An Evaluation of Prairie Producer Attitudes towards Climate Change

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ABSTRACT

Many experts expect that climate change will likely have a significant impact on Canadian prairie agriculture. In turn, agriculture also may have a significant effect on climate. As an identifiable group, agricultural producers should possess some interest in climate change and its effect on agriculture. However, their opinions have not been particularly well documented. In this research, an opinion dynamics model forms the basis for a survey of farmer attitudes towards climate change and its associated risk. Important survey design characteristics include: 1) individual respondent uncertainty, 2) the influence of respondent interaction with others in developing opinions, 3) the role of expert groups in influencing respondent opinions, and 4) the influence of respondent memory of local climate events.

In order to assess producer dynamics on this topic, separate surveys were formulated and administered to both producers and so-called “ag experts”. Both surveys examined the following three components: 1) respondent opinions, 2) respondent views on the other groups’ opinions and 3) the importance of information dissemination. The survey was administered to both producers and experts in Saskatchewan through the summer of 2008 and consisted of over 158 participants.

Producers are classified using standard statistical techniques, including cluster and regression analysis. The survey yielded several intriguing results, including the following:

1) As of the date of the survey, 65% of the sample producers think that there will be considerable climate change and 66% of producers think that climate changes will affect the Canadian Prairies relatively soon (5-25 years). 36% of surveyed producers think that the climate change will be a net cost to Canadian prairies. Only 48% of producers believe human activity has had considerable impact on climate change. These findings hint at the potential difficulty of convincing producers to voluntarily take action to mitigate climate change. The two most important influences on producers are the categories of "*Climatologist"* and "Radio and *TV"*.

2) Producer perceptions of ag expert opinion are mostly inaccurate. In general, farmers think experts have stronger climate change opinions than the experts themselves hold, although the number of experts polled was too small to draw precise conclusions.

3) In comparing communication channels, climatologists/scientists have the highest influence over producers, while radio/television and newspapers/magazines are the second most important source of influence. Somewhat surprisingly, friends and family members have very little influence on farmer attitudes.

Finally, cluster analysis is used to group producers into clusters based on their similarity of opinion. Two methods were used to classify producers. The first method is based on producer most likely values; two clusters were identified: *more concerned producers* (MCP) and *less concerned producers* (LCP). The second method is based on relative belief uncertainty levels. Two clusters were identified: *unconfident producers (UCP)* and *confident producers (CP).* Of

particular interest to policy makers may be the LCP/ UCP group which includes 24% of all producers.

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CHAPTER ONE: INTRODUCTION

1.1 Overview

Climate change is defined as a shift in long-term average weather patterns, which includes changes in temperature and precipitation. Most of the scientific community agree that there has been a measureable change in global climate (IISD, 1997), and in particular, that there has been significant change in global climate in recent years. These changes are attributed directly or indirectly to human activity (like carbon emissions) that alters the composition of the global atmosphere in addition to natural climate variability (Grette et al., 2006). Many scientists believe that if these trends continue, agriculture, entire societies and the world economy will be adversely affected in the future (IISD, 1997).

In addition, scientists point out that Canada will likely be one of the countries in the world most affected by climate change (Barrow, 2010). Temperatures are rising, particularly in the Arctic, where permafrost is thawing and the ocean's ice cover is shrinking. Even greater changes are expected in the future, including a continued rise in temperatures, shifts in rainfall patterns, and increases in certain types of hazardous weather, such as heavy spring rains and heat waves (Watershed Planning, 2008). Because of the influence of climate change on crop production, sea levels and overall weather patterns, a number of human activities in many regions will likely be affected. How people respond to climate change and how social and economic structures are affected are important issues. Notably, Canadian science broadcaster and environmental activist David Suzuki has stated that the Canadian public has a poor understanding of the science behind global warming (Suzuki, 2006). He believes that unless the public understands the seriousness of the situation, they will not change their current habits and move towards a lower carbon economy.

In agricultural regions, potential worldwide climatic changes have raised concerns about potential reductions in crop yields. However, little is currently known about how farmers feel or will react to public policies designed to mitigate and adapt to climate change. Of particular concern in this country are Canadian Prairie farmer attitudes towards climate change and how various demographic and individual characteristics affect their attitudes and beliefs about the issue. These beliefs may have considerable impact on the economic efficacy of public policies designed to reduce Canadian agriculture's contribution to global warming if there is farmer reluctance to participate. Unless farm producers understand and recognize climate change, and believe that they at least partially contribute to climate change in farming production, only then will they be motivated to take action to mitigate[1] and adapt[2].

1.2 Problem Statement

While the reality of increased global temperatures and weather volatility is accepted by many experts, agricultural producer opinions about the issue are poorly understood. Lack of clarity on the part of farmers may stem from confusion between the anecdotal evidence of local extreme weather conditions compared to actual trends in the region (Weber, 1997). Such confusion could

[1] Climate change mitigation is action to decrease the intensity of irradiative forcing in order to reduce the potential effects of global warming (IPCC Glossary, 2009)
[2] Climate change adaptation is a response to climate change that seeks to reduce the vulnerability of natural and human systems to climate change effect (UNFCCC Glossary, 2010). It is distinguished from mitigation to global warming, which involves reduction in concentrations of greenhouse gases by reducing their sources (Molina, Zaeke, Sarmac, et al., 2009)

have a detrimental effect on the rate of adoption of farming practices designed to be compatible with changing climate. Thus, not only is knowledge of farmer opinion towards climate change issues important but their relative level of uncertainty is also critical in assessing their opinions. Since there is a considerable amount of expert information available on climate change, another issue to be explored is the role of scientific experts in influencing farmer opinions on this important policy issue.

1.3 Objectives

Lynne et al, (1995) maintain that the impact of social influence on farmer opinions is affected by the level of certainty or uncertainty in one's opinion or belief about an issue. It is important to measure the level of certainty of farmers' attitudes towards climate change. The primary objective of this thesis is to identify Canadian prairie farmer attitudes towards climate change, how these opinions are influenced by other factors, and how various socio-demographic characteristics affect these attitudes and beliefs. More specifically, the primary purpose of this research is to 1) assess producer attitudes towards climate change, and 2) examine the degree of uncertainty in their attitudes or beliefs as well as the factors underlying this uncertainty. This will be accomplished by a survey and subsequently analyzing the following factors: 1) producer attitudes, beliefs and perceptions about climate change; 2) demographic factors that affect their attitudes, beliefs and perceptions and their associated degree of uncertainty; 3) producer interaction with other producers and how it affects their opinions about climate change; 4) sources of producer information, including the impact of scientific experts and; 5) the impact of local weather events on their attitudes towards climate change.

1.4 Thesis Organization

This thesis is organized in the following manner. In Chapter Two, climate change is defined, and its trends and volatility are briefly explored. The literature describing the importance of climate change to the Canadian prairie region and some potential Canadian government policies that may be enacted in response are reviewed. In addition, the importance of obtaining a better understanding of farmer attitude towards climate change is also emphasized.

The underlying theoretical framework for the analysis is found in Chapter Three. The complexity of the issue means that standard economic models of behaviour and rationality will not be of much use in advancing our understanding of farmer attitudes. Thus in this chapter, the theory of social influence from sociology is introduced. Building upon this theory, I develop two important components of the so-called opinion dynamic model, comprising individual's opinions as well as their associated level of uncertainty.

In Chapter Four, the survey methodology and statistical techniques used to analyze the survey results are discussed. A discussion of the survey questionnaire design based on the Visual Analog Scale is also included.

Chapter Five contains a description of the explanatory variables in the analysis as well as their expected influence. Basic descriptive results, including producer and expert opinions towards climate change are also reviewed.

In Chapter Six, the results of cluster analysis of producer opinions based on three different classification schemes are discussed. Two different classification schemes are chosen representing two dimensions of producer opinions. Factors that influence producer opinions are also identified.

Lastly, a summary of the thesis, conclusions, the limitations of the study and suggestions for future research are provided in Chapter Seven.

CHAPTER TWO: REVIEW OF CLIMATE CHANGE AND AGRICULTURE

2.1 Introduction

Agricultural production is significantly affected by temperature, carbon dioxide, glacial run-off, precipitation and interactions between these elements (Fraser, 2008). At the same time, agriculture generates significant effects on climate change, primarily through the release of greenhouse gases such as carbon dioxide, methane, and nitrous oxide (UN Report, 2007). Since it is believed that climate change may dramatically impact human social and economic activities, how society deals with such a complex issue is of paramount importance. According to Diaz, Sauchyn and Kulshreshtha (2010), the Canadian government has failed to reduce emissions as proposed in the Kyoto agreement[3]: federal and provincial governments are a long way from developing a comprehensive climate policy approach that includes both mitigation and adaptation activities.

This chapter is organized as follows. First of all, the effects of changing climate, especially expected changes in the prairie region of Canada, are discussed. Secondly, the potential impact of climate change on Canadian agricultural production is described. Thirdly, the controversy of the public's opinion on climate change is identified. Finally, Canadian government institutions and policies associated with climate change are highlighted.

[3] Kyoto agreement is also called the Kyoto Protocol. It is a protocol to the United Nations Framework Convention on Climate Change, aimed at reducing greenhouse gas emission. Up to September 2011, 191 states have signed and ratified the protocol (UNFCCC, 2011).

2.2 Climate Change and the Canadian Prairies

The Canadian prairies extend from the Rocky Mountains to southeastern Manitoba, comprising two million km^2 of land (roughly 20% of Canada's area) with a population of 5.4 million (17% of Canada's population) (Census of Agriculture, 2006). One of the important economic drivers in this region is agriculture. According to Statistics Canada (2010), prairie agriculture produced $21 billion worth of goods, including $10.7 billion of crop production (comprising 58% of Canadian crop production) and $7.6 billion of livestock production (42% of Canadian livestock production) in 2010.

According to Kulshreshtha (2010), the expected higher winter temperature would affect the number of frost-free days and growing degree days, and it might lead to a longer growing period for agriculture. In contrast, projected changes in precipitation are less certain. While annual mean precipitation could decrease between 0% and 10% across most of the prairies (Barrow, 2010), more precipitation is expected during the early spring but less during the growing season (Environment Canada, 2010).

With expected temperature increases, prairie frost-free days may increase and as Kharin and Zwiers (2000) note, this effect may be offset by more extreme events, especially drought. In fact, the prairies may be especially vulnerable. The frequency of extreme events such as droughts and floods can affect crop and livestock production as well as the entire Canadian economy.

Kulshreshtha (2010) states that any impacts of climate change on the prairie region would be a significant change for the entire country. He summarizes various ways climate change affects the prairie region (Figure 2.1). In addition to the direct impacts of climate change on agriculture and other nonagricultural sectors, the prairie region would also be affected by a change in the hydrological cycle, which in turn could generate secondary impacts on the prairie economy. These changes and their corresponding effects on agriculture will necessarily require long run adaptation by producers. Agricultural adaptation can take place through selecting different crop varieties or modified crops, new technologies or even structural change. Key to the understanding of this long-run dynamic is the ability of producers to first discern changes and then make the appropriate managerial adjustments. If climatic change is characterized by a steady and consistent transition to a new environment, this could be easily predicted by most producers and their decisions would likely adjust gradually. However, if trends are masked by weather volatility[4] and short-term, unpredictable change, then producers may have trouble distinguishing between a short run climate "blip" and an actual longer term trend. According to Diaz et al. (2010), Canadian producers, one of the key actors in responding to climate change, have thus far not seemed to change farm practices to mitigate climate change such as reducing greenhouse gas emissions. This lack of response may be due to poor or inadequate policies or to limited awareness, lack of knowledge or through confusing and contradictory claims by pundits and scientific experts.

[4] Examples of weather related volatility include extreme weather events of drought/floods and premature frosts.

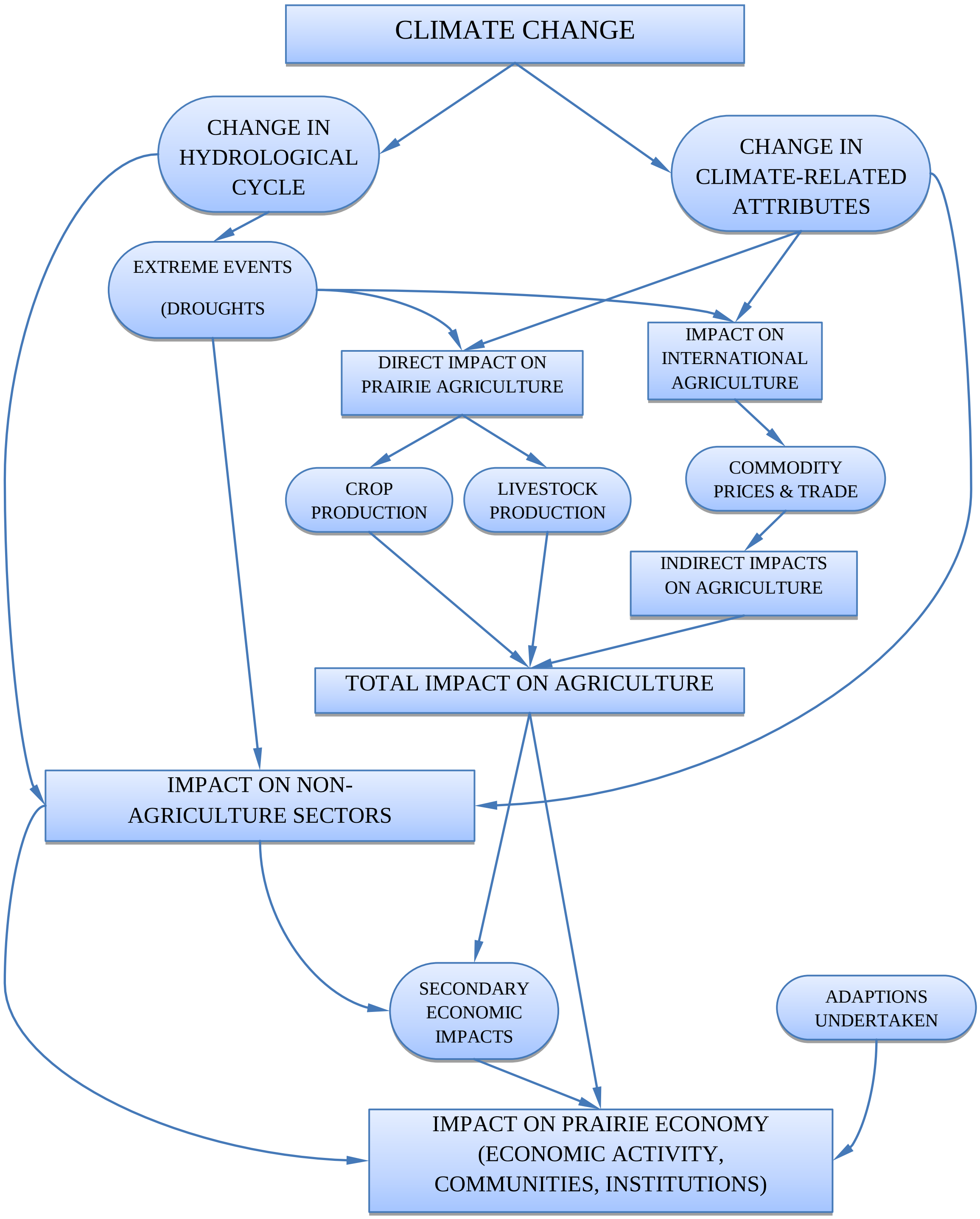


Figure 2.1: Pathways to economic impact on the prairie region under climate change (Kulshreshtha, 2010)

2.3 The Climate Change Controversy

In spite of growing evidence, many people continue to dispute the consequences, nature, and causes of climate change global warming (Boykoff, 2004). Disputed issues include whether the current warming trend is within normal climatic variations; whether humankind has contributed to changes in a significant manner; whether the measured increases are partially or entirely an artifact of poor measurement; and what the ultimate consequences of global warming will be. While most of the scientific communities agree that global warming is human-caused, the opponents believe it is due to the natural, moderate 1500 year cycle (Avery, 2007). What can be concluded is that these widely different opinions towards the causes and consequences of climate change have led to considerable trepidation and confusion worldwide, and prairie farmers are no exception.

2.3.1 Terminology

Climate change is generally defined as a long term change in the statistical distribution of weather patterns over periods of decades or longer (Houghton, 2001). A brief summary of the potential underlying causes of global climate are provided by an environment-related program in the UK (ACE[5]):

> *"The general state of the Earth's climate is largely affected by how much heat is stored in the atmosphere; processes which affect this storage of heat can cause the climate of the Earth to change. It is not just man-made pollution of the atmosphere, which can cause climate change. Changes in the amount of greenhouse gases in the air have occurred naturally during the history of the Earth, leading to climate changes. Changes in the way ocean water circulates around the world can also influence climate, because the oceans store even more*

[5] ACE stands for Atmosphere, Climate & Environment. It was supported by the UK Department for Environment, Food and Rural Affairs (DEFRA) until 2005. It disseminates information on the causes and effects of climate change(Buchdahl, 1999)

> *heat than the atmosphere. Changes in the amount of heat from the sun will affect the Earth's climate too." (*pp56)

Even though there are many potential causes of climate change, some of these are natural, such as a large comet or a meteorite striking the earth. These incidents only happen every few million years. But because the average temperature of the earth near surface air has continuously increased since the mid-20th century, many scientists associate this phenomenon with the greenhouse effect and more specifically attribute these changes to human activity. The United Nations Framework Convention on Climate Change defined climate change in 1994 as the following:

> *"A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (pp89)*

Up to now, climate change has been generally regarded as synonymous with "global warming." Global warming is thought to be caused by thermal radiation being absorbed by atmospheric greenhouse gases, which is then re-radiated in all directions (Annex II Glossary, 2010). There is a growing consensus that the increasing trend of global surface warming is mainly caused by human induced emissions of greenhouse gases (Brigham-Grette et al. 2006). Another important effect of climate change is increased temperature volatility (Carvalho, 2007).

The United Nations Framework Convention's definition of climate change is preferred for this research as it is clear and concise, and can be easily understood by Canadian farmers, making it easier to measure producer opinions. This is particularly important in developing survey questions that investigate opinions towards potential factors in climate change such as man-made pollution.

2.3.2 Public and Farmer Opinion as to Global Climate Change

The widespread prairie drought of 1988 heightened regional public awareness as to the importance of climate (Mccright & Dunlap, 2000). In the same year, Hansen and Lebedeff (1988) attributed the abnormally hot weather *"plaguing our nation"* to global warming. By 1990, many European countries had already taken action to reduce greenhouse gas emissions, and all European Union member states ratified the 1997 Kyoto protocol[6]. Since then, the climate change issue has attracted greater media attention. By 2005, both the term "global warming" and the more politically neutral "climate change" were listed by the Global language Monitor[7] as catch phrases.

Langer (2006) reports that 49% of Americans believe that climate change is very important. Another study reports that 59% of Americans believe that climate change is a serious problem and major steps need to be taken very soon to mitigate it (GlobeScan, 2006). Another report on UK public perception (Ipsos MORI[8], 2007) reveals the following: 1) 88% of survey participants believe that climate, irrespective of the cause, is changing; 2) 41% of survey participants believe that climate change is caused by both human activity and natural processes and of that group, 46% believe that human activity is the main cause; 3) 44% of survey participants are very concerned. Nevertheless, there remains a large proportion that is yet to be fully persuaded about the extent of the threat; 4) 45% of survey participants say it is the most serious threat facing the world today and; 5) 53% believe it will impact significantly on future generations. Somewhat

[6] Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC or FCCC), aimed at fighting global warming (Kyoto Protocol Annex B, p 21).
[7] GLM is a Texas-based company that collectively documents, analyzes and tracks trends in language usage worldwide, with a particular emphasis upon the English language (Kristof 2008).
[8] Ipsos MORI is a well known market research company UK.

surprisingly, few people (9%) thought that climate change would have a significant impact upon them personally.

A more recent 2009 survey, entitled "Europeans' Attitude towards Climate Change ", notes that 87% of Europeans consider climate change to be a "serious" or "very serious" problem, while only 10% do not consider it to be serious (TNS Opinion and Social, 2009). While there are numerous surveys of attitudes towards the issue, the general trend is that individuals are becoming more and more concerned about global climate as well as what might be done about it.

There is considerable debate among public commentators about how much weight and media coverage should be given to each side of the controversy. As Andrew Neil [9] stated on BBC:

> *"There's a great danger that on some issues we're becoming a one-party state in which we're meant to have only one kind of view. You don't have to be a climate-change denier to recognize that there's a great range of opinion on the subject."(McCarthy, 2007, pp36)*

Moreover, there are considerable differences between the opinion of scientists and the general public (Pew Global, 2006). Pew Global Research Center [10] conducted a 15 nation poll in 2006 and found that:

> *"There is a substantial gap in concern over global warming – roughly two-thirds of Japanese (66%) and Indians (65%) say they personally worry a great deal about global warming. Roughly half of the populations of Spain (51%) and France (46%) also express great concern over global warming, based on those who have heard about the issue. But there is no evidence of alarm over global warming in either the United States or China – the two largest producers of greenhouse gases. Just 19% of Americans and 20% of the Chinese who have heard of the issue say they worry a lot about global warming – the lowest percentages in the 15 countries surveyed. Moreover, nearly half of*

[9] Andrew Ferguson Neil, born in 1949, is a Scottish journalist and broadcaster.
[10] Pew Global Research Center is an American think tank organization based in Washington, D.C. that provides information on issues, attitudes and trends shaping the United States and the world.

> *Americans (47%) and somewhat fewer Chinese (37%) express little or no concern about the problem."(2006, pp58)*

As previously noted, David Suzuki has pointed out that the Canadian public has a poor understanding of the science behind global warming (2006). He believes that if the public understands the seriousness of the situation, they will then change their habits and start to move towards a low carbon economy. If there is some confusion by the general public, then it is not too unsurprising that there may be some confusion among farmers. In a 2007 case study of 30 Manitoba farmers' responses to climate change, Tarleton and Ramsey (2008), found that while almost farmers had a concern about climate change, their opinions varied considerably as to warming or cooling effect of climate change. Respondents were also divided as to the impact of climate change on their farming operations. Only four farmers indicated a positive effect, eleven indicated a negative effect and six indicated both positive and a negative effect. The remaining respondents seemed to have little awareness of the potential agricultural impact of climate change.

2.3.3 Canadian Government Response

The Government of Canada has tracked actual greenhouse gas emissions since 1990 as part of the response to climate change. The current national greenhouse gas emission target is 20% below 2006 levels by 2020, which is a reduction of 577MT. Two federal government ministries have been tasked with the issue: Environment Canada and Natural Resources Canada. Many other agencies and departments also have roles in relation to climate change, including the ministries of agriculture, fisheries and health. The three prairie provincial governments have similar challenges in responding to climate change: Alberta Environment and the Alberta

Ministry of Sustainable Resource Development are tasked with addressing climate change in Alberta; the Ministry of the Environment has been central in developing a climate strategy in Saskatchewan; and Climate and Green Initiatives branch of Manitoba Science, Energy and Mines are tasked with coordinating the Manitoba government's climate change plan. Provincial and federal ministries efforts appear to overlap as the jurisdictions of natural resource management are shared by mutual agreement (Hurlbert and Corkal, 2010).

The prairie provincial and federal governments have responded to climate change by developing two major types of policies: 1) reducing greenhouse gas emissions (mitigation of climate change), and 2) increasing adaptive capacity to climate change (adaptation). Mitigation related policies were first introduced in 1998. The three prairie provinces have committed to the reduction of greenhouse gases with targets not always in accordance with those assumed by Canada in the Kyoto agreement. Hurlbert and Corkal (2010) summarized three provincial 2020 greenhouse gas target levels. It concludes that both Alberta and Saskatchewan have potentially larger mitigation problems than Manitoba as their oil and natural gas production that Manitoba lacks. In addition, electricity produced in Alberta and Saskatchewan is based on non-renewable fuels while in Manitoba production is primarily based on hydropower. This is reflected in their targets: Alberta has to meet a net target value of 250 Mt, while Saskatchewan has to meet a value 58 Mt, and Manitoba has to meet a target value of 17 Mt (Hurlbert and Corkal, 2010). Hurlbert and Corkal maintain that these provinces have focused their efforts on mitigation of carbon dioxide emissions with only consideration for developing an adaptation strategy in the future (Hurlbert and Corkal, 2010). Therefore, the development of adaptive capacity in these provinces is limited and it seems adaptation is not an important component of Alberta and Saskatchewan's current climate change policies.

2.4 Summary

Many have asserted that agriculture is an important contributor to climate change across the globe, and thus to date, federal and provincial governments in Canada have exerted greater efforts on mitigation of greenhouse gas emissions than adaptation to climate change impacts. However, there seems to be considerable differences in farmer and public understanding of climate change. In the case of agriculture, unless farmers recognize that climate change is occurring and can understand that farming at least partially contributes to the problem, then they will not take action to mitigate[11] and adapt[12] even when government and other organizations have suggested alternatives. This means that policy makers or climate change related organizations should have a good understanding of farmer opinions and how they are shaped by public or private discourse on the topic.

[11] Climate change mitigation is action to decrease the intensity of irradiative forcing in order to reduce the potential effects of global warming (IPCC Glossary, 2009)

[12] Climate change adaptation is response to climate change that seeks to reduce the vulnerability of natural and human systems to climate change effect (UNFCCC Glossary, 2010). It is distinguished from mitigation to global warming, which involves reduction in concentrations of greenhouse gases by reducing their sources (Molina, et al., 2009)

CHAPTER THREE: CONCEPTUAL FRAMEWORK

3.1 Introduction

In the previous chapter, I argued that global climate change is important and it generates novel and possibly complex policy issues as a response. In addition, differing opinions among experts can cause confusion among producers. Further confusion and uncertainty may also be caused by the masking effect of local weather events, which can introduce considerable uncertainty as to the actual trend rate or even if such a trend exists (Webber, 1997).

Behavioral economics incorporates social, cognitive and emotional factors to understand economic decisions of individuals (Ainslie, 1974). As some agricultural technology diffusion / adoption research shows, producer environmental values, attitudes, farming styles and personality characteristics play an important role in their economic behavior (Webber, 1997; Maybery et al., 2005; Lynne et al., 1995). For example, Webber (1997) points out there are significant correlations between producer's beliefs on climate change and observed farming decisions[13]. Lynne et al. (1995) compared the Theories of Planned Behavior, Reasoned Action, and Derived Demand in studying perceived control in the farming decision. They found that both actual financial capability (actual control) and perceived control are important, and that government over-intervention in farm producer technology decisions could be counterproductive. Maybery et al. (2005) also point out the importance of taking into account the heterogeneity of farm producers in policy development. They categorize farmers into three groups based on different valuation of economic, conservation and lifestyle factors. They believe

[13] The seven farming decisions include:1) what varieties of corn to plant, 2) when to start planting, 3) what tillage practice to use, 4) whether to buy, replace or rent new equipment,5) whether to purchase crop insurance and how much, and 6) how to price the crop(Webber, 1997).

that this classification could be used to formulate more effective land conservation policies. These studies suggest that rural sociological and psychological factors are essential in understanding the adoption of conservation technologies. Hence, in order to understand the rate of adoption of farming practices and farmers' reaction to significant policy intervention, we seek to understand producers' attitudes towards climate change and associated policies.

This study aims to identify farmers' attitudes towards climate change and the degree of certainty in their opinions. However, unlike standard economic psychology models (e.g, the theory of planned behavior) (Lynne et al. 1995), this study focuses on how farm producer opinions are formed instead of how they make their decisions based on their opinions. Therefore, this thesis examines 1) how experts influence producer opinion, and 2) the level of accuracy with which producers view expert opinion. Since theories developed in rural psychology are better suited to understand and explain the forming of attitudes and perceptions in this context, this study adopts social influence theories developed in rural psychology in analyzing farmer attitudes and perceptions. The following section reviews the sociology and psychology literature on social influence on famer attitudes.

3.2 Theory of Social Influence

An attitude is a hypothetical construct that represents an individual's degree of positive or negative views of a person, place, thing, or event. Most attitudes are the result of either direct experience or observational learning from the environment and could be changed by social influence. All interpersonal behavior involves influence process (Camerer, 2003). The theory of social influence was first introduced by a Harvard psychologist, Hebert Kelman in 1958 in terms of three components: compliance, identification, and internalization. He states that compliance occurs when people appear to agree with others, but actually keep their dissenting opinions private; identification is when people are influenced by someone who is liked and respected, such as a famous celebrity; and internalization is when people accept a belief or behavior and agree both publicly and privately (Kelman, 1958). This approach argues that there are two psychological needs that lead humans to conform to the expectations of others, which include "need to be right" (informational social influence), and "need to be liked" (normative social influence) (Deutsch & Gerard, 1955). Informational influence is also known as social proof. This is the willingness to accept information from other people as evidence about reality. Informational influence comes into play when people are uncertain, either because stimuli are intrinsically ambiguous or because there is social disagreement (Aronson & Akert, 2005). Normative influence is best described as a need to conform to the positive expectations of others. This often leads to public compliance, whereas informational influence leads to private acceptance (Kelman, 1958).

Social influence occurs when an individual's thoughts or actions are affected by other people intentionally or unintentionally and changes the way people perceive themselves in relation to the influencer, other people and society in general (Forgas &Williams, 2001). It takes many forms and can be most easily observed in concepts such as conformity, socialization, peer pressure, obedience, leadership, persuasion, sales, and marketing (Cialdini, & Goldstein, 2004). There are many theories of social influence but the five highlighted below are believed to have potential bearing on farmer attitude towards climate change. These are 1) Dynamic Social Impact

Theory, 2) Structural Approach to Social Influence, 3) Social Influence Network Theory, 4) Structural Approach to Social Influence Expectation Theory, and 5) Expectation States Theory. Each of these will be presented in some detail below.

3.2.1 Dynamic Social Impact theory

Latane (1981) first developed social impact theory in 1981. He believed that any number of changes that might occur in an individual (physiological, cognitive, emotional, or behavioral) are due to the presence or action of others, who are either real, imagined, or implied (Rashotte, 2006). Social impact theory proposes that the impact of any information source is a function of three factors: the number of individuals who make up that source, immediacy, and the effect of strength (Latane, 1996). Dynamic social impact theory uses these ideas to describe and predict the diffusion of beliefs through social systems (Rashotte, 2006). From this point of view, social structure is the result of individuals influencing each other in a dynamic and iterative way. Ultimately, dynamic social impact theory views society as a self-organizing, complex system in which individuals interact and affect each other's beliefs. The higher possibility of being influenced by someone located nearby, rather than someone located far away, produces localized cultures of beliefs within communication networks (Rashotte, 2006). This process can lead to randomly distributed attitudes and beliefs becoming clustered or correlated and less popular beliefs become consolidated into minority subcultures.

3.2.2 Structural Approach to Social Influence

Like dynamic social impact theory, the structural approach to social influence examines interpersonal influence that occurs within a larger vinculum[14] of influence (Rashotte, 2006). Attitudes and opinions of individuals are the reflections of the attitudes and opinions of their referent[15] others in a large network. Structure determines the initial positions of group members and the network links as well as the weight of interpersonal influences within the group. While interpersonal influence is seen as a basis of the individuals' socialization and identity, social influence is considered as the route by which a group of actors weigh and integrate the opinions of significant others within the context of social structural constraints (Rashotte, 2006).

3.2.3 Social Influence Network Theory

Friedkin (1998) described social influence network theory as a two-stage weighted average of influential opinions. Individuals start out with their own initial opinions on some matter, and modify their opinion in response to a "norm" which in turn is a weighted average of other opinions in the group. This theory utilizes formal mathematical models and quantifications to measure the process of social influence.

3.2.4 "Structural Approach to Social Influence Expectation" Theory

The Structural Approach to Social Influence Expectation theory provides another formal explanation of social influence. This theory is rooted in the work of Bales (1950), who found

[14]Vinculum: A bond or link signifying union (Collins English Dictionary,2009)

[15] Referent: original from Latin reference. It is the object or idea to which a word or phrase refers (Collins English Dictionary,2009)

inequalities in the degrees of influence group members had over one another. Bales discovered that even when group members were equal in status at the beginning of the group session, over time some members would end up being more influential than others. Based on this finding, a hierarchy based on the behaviour of the group members was developed. Researchers in this tradition developed systematic models predicting the relative influence of task-oriented actors in group settings. Interestingly, larger group hierarchies based on age and sex for example, can be imported to smaller sub-groups, even they though differ considerably in composition from the larger group. (Rashotte, 2006).

3.2.5 Expectation States Theory

Expectation states theory was originally proposed as an explanation for Bales' findings (Rashotte, 2006). According to this theory, group members develop expectations about the future task performance of all group members, including themselves. Once the expectations are developed, these would guide the group interaction and are reinforced by further interaction. Group members with the highest expectations are generally are the most influential in group interactions.

3.3 Opinion Dynamic Model

The opinion dynamic model is a simulation model based on social influence theory to understand how opinions are scattered between population extremes and marginal groups and spread throughout the remaining population. Important components of these models are the individual's own opinion and the level of uncertainty in their opinion. People are assumed to interact randomly. When different people meet, one person may influence another person's opinion if their opinion “segments” overlap. If the opinion segments do not overlap, then they have no chance of influencing each other (Hegselmann and Krause, 2002). Different opinions interact if and only if the opinions overlap to some extent. Moreover, the opinion of a person who has less uncertainty about their opinion has more influence on another person’s opinion. Hence, two important elements of opinion dynamic models are not only individual opinion but the relative uncertainty of their own opinions. In this thesis, while the opinion dynamics model is not explicitly used, efforts are made to measure the two important elements of opinion dynamic: participant opinion on climate change and the associated confidence / uncertainty level as to own opinion. These two variables will be key factors used to measure producer opinions in this study.

3.4 Summary

Producer beliefs and attitudes are formed in a complex manner under dynamic uncertainty. It is necessary to identify important factors that influence producer attitudes towards climate change since producer attitudes could affect their farm production decisions and their acceptance of climate change policy. Another area of interest is the relationship between producers and agricultural climate “experts.” Accordingly, based on the purpose of this research, the opinion dynamic model is chosen as the most useful conceptual framework to guide survey design in this study.

CHAPTER FOUR: SURVEY DESIGN AND EVALUATION

4.1 Introduction

In applying opinion dynamic theory to a survey of producer climate change opinions, it will be important to understand how individual producer beliefs about climate change are likely to be influenced by other members in their social network and also by the so-called experts. In addition, the dynamics of belief formation will likely result in some degree of belief uncertainty. In order to better understand farmer attitudes towards climate change, and to gain insights about their adaptation and mitigation plans under a variety of different climate change scenarios, a survey instrument was developed. Based loosely on an opinion dynamic model, two similar surveys were designed for two different groups: producers and experts.

This chapter outlines the methodology used in designing the producer/expert survey. Three types of questions are delineated: 1) individual opinions towards climate change; 2) the perceived opinion of the other group; and 3) the influencing power of different media sources in shaping participant opinions. Next, the *Visual Analog Scale* method used in questionnaire design is reviewed. This is followed by a section defining variables that measure 1) best guess or most likely values, and 2) individual uncertainty levels. Then, several statistical models and cluster analysis are used to analyze and classify producer attitudes towards climate change and climate change policies.

4.2 Survey Design

4.2.1 Questionnaire

There are two surveys used in this research: a producer survey and an expert survey[16]. Both producer and expert surveys are divided into four sections: 1) climate change opinions; 2) the influence of experts on producers (producer survey) or experts' opinion as to producer belief (expert survey); 3) the influence of social media on participant (expert or producer) opinions; and 4) demographic and farm business characteristics. Using the producer survey as an example, there are 17 questions in total, arranged in three sections (Q1-6, Q7-14, and Q15-17). These major sections are described below (see the Expert Survey in Appendix 1.3).

4.2.1.1 Climate Change Opinions

In this part of the survey, producers were asked six questions about their own attitude towards climate change and its underlying cause. The questions were:

> Q1. Do you think that global climate is changing?
>
> Q2. If you were to actually experience one or more years of an extreme weather event (e.g. the prolonged drought in Australia; the extremely hot summer in Europe in 2003; the intense North Atlantic hurricane seasons of 2004 and 2005 or the extreme rainfall events in Mumbai, India in July 2005), do you think this would affect your opinion on the issue?
>
> Q3. How much have you changed your “climate” opinion in the past 10 years?
>
> Q4. For the moment, assume <u>there will be some permanent climate change on earth.</u> Given this, what do you think will be the overall effect of climate change on Canadian prairie farm production?
>
> Q5. Again assume <u>there will be some level of permanent climate change.</u> How long do you think it will take before climate change begins to seriously affect your personal or business life, requiring you to make changes and adapt?

[16] Experts are defined as those which are "self recognized" , who have some climate change expertise, but may work in other areas such as agricultural extension as an educator and researcher.

> Q6. Finally, do you believe that global climate or "average weather" change is mostly caused by human activities?

4.2.1.2 Producer Perceptions of Expert Opinion on Climate Change

In this section, Q1 relates to Q7, Q4 relates to Q8, and Q5 relates to Q9. The questions are similar, except changes have been made to reveal producer perception of expert views. This should help to understand how producers perceived experts' own views on climate change. Three questions were asked:

> Q7. Tell us what you think the experts are currently saying about climate change.
>
> Q8. Tell us what you think the experts are saying about the net benefits/costs of climate change to the Canadian Prairies.
>
> Q9. Tell us what you think the experts are saying about how long it will take before climate change will begin to seriously affect the Canadian Prairies.

4.2.1.3 Social and Media Influence

In question 10, producers were asked to indicate the influence of the experts and others on their own opinions about climate change.

> Q10. Indicate the influence of the following “experts” on your own opinions about climate change.

There are eight different categories of “experts”: climatologist or scientists (A), environmental groups (B), newspapers and magazines (C), radio and TV (D), internet (E), friends (F), family members (G), and others (H). The purpose of having questions about external influence on participants is to find out the important factors that affect producers' opinion on climate change.

4.2.1.4 Demographic and farm business characteristics

Farm producers' age, gender, farm size and farm type were asked in the last section (Table 4.1).

Table 4.1: Producer Demographic Question

Age	**Gender**	**Land Farmed 10years**	**Farm Type (base on income)**	**Farm Size**
☐ <30 ☐ 30 - 40 ☐ 40 - 50 ☐ 50 - 60 ☐ >60	☐ male ☐ female	☐_% owned ☐_% leased	☐ grain ☐ livestock ☐ mixed: ____% grain ____% livestock ☐ other (_____)	☐<160acres ☐ 160 - 640 ☐ 640 -1280 ☐1280-5120 ☐ > 5120

4.2.2 Question Format

Two types of question formats are used in the survey. For the first question type (discrete response), categorical responses are required. For example, Question 3 asks "How much have you changed your 'climate' opinion in the past 10 years?" The questions on demographic characteristics use this type of format. An example of the discrete question format as used in the producer survey is displayed in Table 4.1.

The second question type uses the visual analog scale method for response, which is described below. This method is useful when the intensity of attitude or preference towards a complex and subtle issue like climate change needs to be measured. In this case, respondents are not only asked to indicate their "best guess" or most-likely-value (MLV) on a climate change related issue along a horizontal line, but also to indicate using a circle the range of certainty around their

(MLV) response. Using question 1 as an example - "Do you think that global climate is changing?” (Figure 4.1). Here, the two end points are denoted as "No Change" and "Considerable Change." "No Change" is further described as "climate change is not unusual, but a normal weather variation." "Considerable Change" is defined as "1) Warmer and fewer cold days and nights, 2) More frequent heat waves, heavy precipitation events, droughts over larger areas, 3) More intense tropical cyclone, hurricanes and tornadoes, 4) Higher sea levels". Note that the X mark on the scale indicates the participant "best guess" or most likely point estimate of what they think about climate change, and in conjunction with the drawn circle indicates their range of uncertainty. The more uncertainty respondents feel about their opinion, the larger circle they are asked to draw.

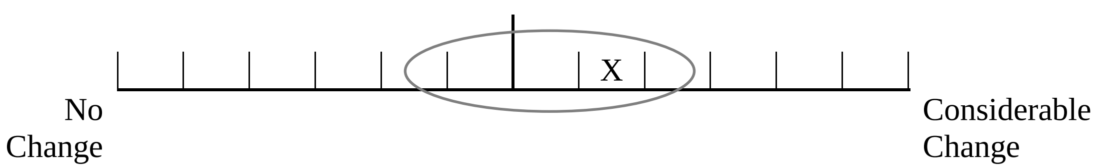


Figure 4.1 Example of a visual analog scale question that measures both *MLV* and *R*

In fact, my X and circle technique is a variation of the so-called triangular technique in surveying[17] where participants define a triangular distribution by specifying lower (L) and upper (U) bounds and most-likely-values (MLV). But notice that no underlying distribution of uncertainty is assumed here. The X and circle technique has some important advantages in that

[17] The elicitation of risk using triangular distribution has a long history in agricultural finance. In the past, many of the responses associated with the triangular distribution had a natural value such as yields or prices. A recent example includes Turvey and Kong (2009) in the *China Agricultural Review* but its use goes back much further in history.

responses do not necessarily need to be symmetric and the narrowness of the response is postulated to correlate with the strength of respondent conjecture. For instance, participants might mark only their MLV value with no circled range if they are absolutely certain about their response. In the other extreme, if they are completely uncertain about their single MLV, they might only indicate a circle without even specifying a MLV. Other possibilities include asymmetric circular responses: if respondents feel that there is more downward uncertainty than upward they would mark the MLV closer to the upper bound value than to the lower bound and the opposite holds true if they are more uncertain about the lower bound. Hence, the technique allows us to reveal wide variations in opinion and expectation patterns. There could be significant heterogeneity in these responses, and this heterogeneity can be used to profile farm producers. This is discussed in greater detail in section 5.4.

4.2.3 Introduction to the Visual Analog Scale

As indicated by the opinion dynamic model, important components of understanding individual opinion are not only “best guesses” but also the level of uncertainty in their opinion. The visual analog scale (VAS) is a linear scaling technique chosen to frame the survey questionnaire since it can measure both an individual point or most likely opinion value as well as uncertainty range. This technique has been used in the social and behavioral sciences to measure a variety of subjective phenomena (Grant, et al., 1999). As such, VAS was first proposed by Freyd (1923) with a suggestion of the use of an 'unnumbered graphic scale' to collect respondent rating in a survey. In fact, the technique was actually used for the first time by Hayes and Patterson in 1921 (Ahearn, 1997).

VAS works using a continuous line between two end points, characterized by an “anchor” at each end representing the extremes of the variable being measured (Svensson, 2000). A similar rating scale called the graphic rating scale (GRS) is also used in research, but GRS adds a verbal description along the visual representation of the line. An example is illustrated in Figure 4.2.

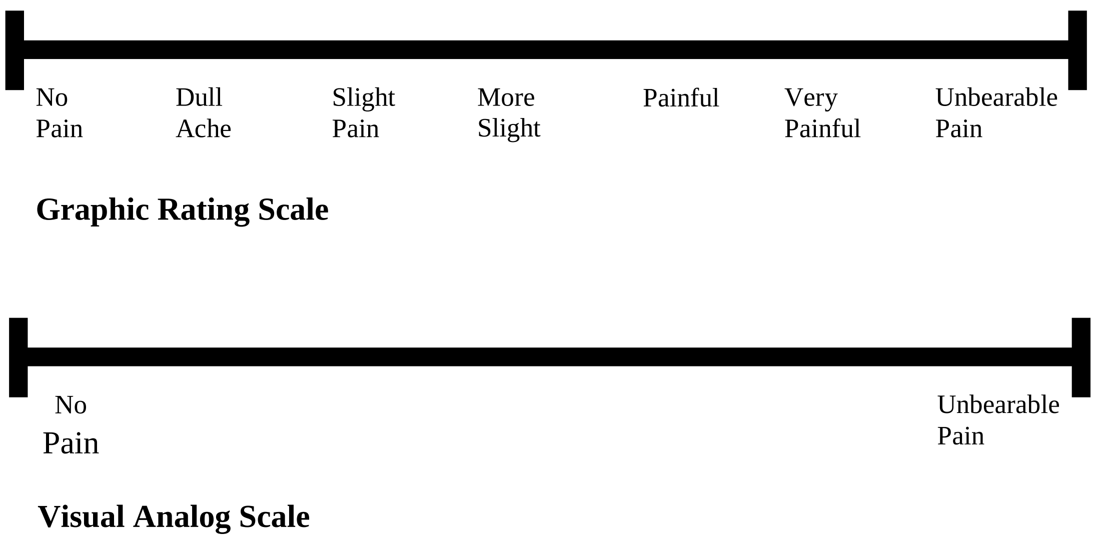


Figure 4.2: Example of a Graphic Rating Scale and a Visual Analog Scale

Source: Mattacola, Perrin, Gansneder, Allen, and Mickey (1997).

These rating scales are sometimes contrasted against discrete measurement scales, a survey technique where respondents select a number or description that most closely represents their positions on the specified scale. Gerich (2007) compared VAS and 5-point categorical self-control scales for both paper and computer assisted formats. He concluded that there are a number of advantages to using VAS. First of all, less direct explanation about the questions and scales to surveyed participants, and he also argues that the measurements yielded by VAS are more accurate. The former benefit also decreases time to complete the survey, increases completion rate, and reduces missing values. VAS allows the researcher to generate interval/ratio measured data out of subjective data. These scales are especially useful for measuring uncertainty on the lower and upper bounds of responses.

4.2.3.1 VAS Response Measurement

In the survey design, the VAS questions incorporate a 10cm horizontal line, anchored by a word descriptor at each end. The word descriptors on the left and right end of the line are scaled from 0 and 10. A middle point is added for convenience and designated as 5. Producer response values are determined by measuring the length between 0 and a marked value in millimeters. For each VAS question, four values are recorded: a most-likely-value (MLV) or "best guess" value of participant's opinion as indicated by the “***X***” on the sliding scale; the lower (L) and upper (U) bound values as indicated by lower end of the circle and the upper end of the circle respectively; and the range (R) of a participant's uncertainty as indicated by the distance between the lower end of the circle and the upper end of the circle.

4.2.4 Survey Administration

The survey was approved by the University of Saskatchewan Behavioral Research Ethics Board. To ensure that survey language and format could be easily understood by respondents, various terms were defined as clearly as possible on the first page of the survey. In addition, an early draft of the survey was pre-tested with university students possessing a farming background. When participants received the survey they were informed of their rights - participation was voluntary and individuals had the right to withdraw at any time. Consent is considered to be implied if the participant completed the survey. The cover letter of the survey also provides further information for the participants, i.e. where they can obtain research results after participants complete the survey.

In order to obtain a broad spectrum of responses at low cost, producers were approached at a major crop production show while experts were interviewed through a number of meetings and workshops or conferences around the same time as the producer surveys were collected. More details for the survey mode are reported in the data collection section of the next chapter (section 5.2.1).

4.3 Methods of Assessing Respondent Opinion and Uncertainty

The major objectives of this thesis include assessing producer opinions towards climate change and the degree of certainty/uncertainty associated with these opinions. One way of simplifying assessment is to identify clusters of individuals with common opinions and or characteristics. Producers can then be profiled in terms of common socio-demographic or farm characteristics. Clustering and profiling producers with different opinions may help better explain their heterogeneity in attitudes towards climate change. To this end, data clustering methods are reviewed in the following sections.

4.3.1 Data Clustering

Data clustering is a common form of statistical analysis used in many fields, including machine learning, data mining, pattern recognition, image analysis, and bioinformatics. It is also called segmentation analysis or taxonomy analysis. Data clustering identifies a set of groups or clusters according to trait-defined similarity within a cluster and dissimilarity based on distance between clusters. There are many different methods of clustering (Garson, 2008). However, the most commonly used methods are hierarchical, and K-means, which are described below.

4.3.1.1 K-means clustering

In K-means clustering, the number of clusters is predetermined. The objective of clustering is to minimize total intra-cluster variance, or the squared error function. Members are assigned to a cluster with the nearest center point (Aldenderfer and Blashfield, 1984).

One of the disadvantages of K-means cluster analysis is that it requires cluster numbers to be pre-specified, and the sample size to be greater than 200. In addition, the K-means cluster technique is very sensitive to outliers, leading to the suggestion that outliers should be removed before the analysis. Nevertheless, its simplicity makes it attractive as a first approach to use before using more advanced methods, like hierarchical clustering (Garson, 2008).

4.3.1.2 Hierarchical clustering

An alternative to K-means clustering is hierarchical clustering, which requires that all possible distance matrices between all pairs of cases be constructed (Norušis, 2000). There are two ways to group data: agglomerative (forward) clustering and divisive (backward) clustering. Agglomerative hierarchical clustering starts with each individual as a cluster. Clusters are iteratively consolidated into larger clusters based on similarity until only one cluster remains. In contrast, the opposite procedure is used in divisive hierarchical clustering. All individuals are aggregated into one cluster and then clusters are step-wise disaggregated based on dissimilarity or distance until all individuals occupy a unique cluster (David Garson, 2008).

4.3.1.3 Hierarchical versus K-means Cluster Analysis

Both hierarchical and K-means clustering techniques can be used to identify and compare groupings. However, hierarchical clustering works better for small samples where it is able to generate all possible clusters. K-means cluster analysis does not require all possible distances to be measured, but only the distance between each case to cluster mean (Norušis, 2000). Based on the features of the two different procedures, and in order to find the best number of clusters, the hierarchical cluster analysis is first used to determine the number of clusters. Then the K-means clustering method is used to group farmers with different attitudes.

4.3.2 Explaining Cluster Membership Using Discrete Choice Models

Clustering analysis results in a small number of discrete groups. It will be interesting to examine the profile of farmers in different groups. A logistic discrete choice regression model is therefore used to explore the relationship between group membership and demographic variables such as gender, age, tenure, farm type, and farm size (McFadden 1974). In this section, the simple logit model is briefly introduced. And depending on the number of clusters resulting from the clustering analysis, two types of logistic regressions will be used in this thesis: 1) a binary logit model (a dependent variable has two categories), and 2) a multinomial logit model (dependent variable has more than two categories).

Since the dependent variable, group membership, is discrete, traditional ordinary least squares (OLS) regression, which assumes that the dependent variable is continuous, is ill-suited to explain this kind of membership. A logit model is used to deal with the discrete nature of group membership. As Demaris (1992) concludes: 1) in comparison to OLS regression, which assumes a linear relationship between the dependent and independent variables, a logit model does not impose such an assumption; 2) OLS assumes the distribution of error terms is normally distributed, but in logistic regression, the distribution can be either normal, Poisson or binominal; and 3) OLS assumes there is equal variance between all independent variables, but logistic regression does not require this assumption. Logistic regression assumes that the error term is independent, and that there should be no statistical outliers. It is a useful and more flexible tool for describing the relationship between one or more independent variables and a binary or more than two possible response variables, expressed as a probability (Agresti, 2007). Since one objective of this study is to find out the relationship between producer demographic variables (e.g. gender, age, etc.) and categorized producer response on climate change, logistic regression is the chosen analytical methodology.

4.3.2.1 Binary Logit Model

The binary logit model is a type of multiple regression model in which the dependent variable is dichotomous. This means it only has two different values, 0 or 1. A standard logistic function is shown as follows (Agresti, 2007).

where P is the probability and t is usually defined as:

$$t = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_k x_k$$

As Allison (1999) shows, the logistic equation can also be written as:

Where there are k^{th} independent (X) variables, β_0 is the intercept, and $\beta_1 \ldots \beta_k$ are regression coefficients of $x_1, x_2, \ldots, x_k$.

The expected log odds are the odds ratio or probability associated with the occurrence of the dependent variable. In a binary logistic regression, usually the odds of the event occurring are represented as the dependent variable = 1 rather than 0.

4.3.2.2 Multinomial Logistic Regression

Similar to binary logistic regression, multinomial logistic regression is also a multiple regression specification that predicts the value of the dependent variable using a set of independent variables. In practice, multinomial logistic regression is used in cases where the response is not binary in nature, but has more than two discrete outcomes. For instance, assuming there are three levels of dependent variable (denoted as 1, 2, 3), with one category (1) considered to be the reference category. The model can be written as follows:

and

β and γ are regression coefficients that are to be estimated. As an example relevant to this thesis, assuming farm producers can be categorized into three groups based on their opinions, a multionomial logistic regression could then be used to explain the likelihood that a producer with certain demographic characteristics such as age, gender, farm size and farm type falls into one of the three groups. Accordingly, farm producer classification is the dependent variable and the demographic characteristics are independent or explanatory variables.

4.4 Summary

This chapter first discussed separate surveys administered to producers and experts. Next, the visual analog scale method format was explained. Then, two measures for respondent attitudinal responses towards various questions are introduced: one for the most likely value, and the other measuring the degree of uncertainty. Lastly, statistical cluster analysis and logit regression models used to formulate and explain group membership are described. The next chapters outline the results of the survey itself and the subsequent analysis of producer replies.

CHAPTER FIVE: PRODUCER AND EXPERT OPINIONS TOWARDS CLIMATE CHANGE

5.1 Introduction

This chapter reports the results of a survey of farm producers and agricultural expert attitudes towards current projections about future climate change. From several survey locations, a total of 135 producers participated in the producer survey, and 23 experts participated in the expert surveys. While the size of the expert population is relatively small, I feel that it still adequately represents key population characteristics. Finally, recall that the primary purpose of this study is to evaluate producer opinions towards climate change; accordingly, the primary focus of the analysis is on the producer survey results while the expert survey results are provided for comparison purposes.

This chapter is organized as follows. First, the survey modes for data collection are reviewed. Second, the socio-demographic characteristics of the producers are described and compared to the 2006 Census of Agriculture data. Third, the different types of VAS format with different labels on two ends of a scalar are summarized. Fourth, descriptive statistics of producer attitudes towards climate change are reported. Fifth, a brief introduction to the expert responses is presented, and expert and producer responses are compared. Lastly, five different types of measures of uncertainty in their opinions are constructed to analyze producer responses.

5.2 Survey Overview

5.2.1 Producer Survey: In - person interview and mail survey

Producers were surveyed through direct contact and mail out questionnaires. The direct person contact was conducted by randomly selecting farmer participants at the Western Canada Farm Progress (WCFP) Show[18]. The WCFP show, which was held from June 20-22 in 2008, is the largest farm technology show in Canada, and a total of 107 farmers at the show agreed to participate in the survey. This survey mode helps to reduce survey cost, increase response rate and ensure the quality of survey data.

A mail-out survey was subsequently sent to the randomly selected members of the Agricultural Producer Association of Saskatchewan (APAS) in July 2008. This survey mode is used to supplement the sample size and to test for sample selection bias that might result from the on-site interviews at the WCFP show. However, out of 200 surveys that were sent out, only 28 survey responses were received. Accordingly, the effective response rate of mail-out survey mode (19%) is much lower than the in-person contact survey mode.

5.2.2 Expert Survey: Personal Intercept in Conference Events

A separate survey was administered to experts. As previously mentioned, experts are identified as those who have some climate change expertise, but may work in other areas such as agricultural extension as an educator and researcher. Hence, these individuals are perhaps better

[18] The Western Canada Farm Progress Show was established in 1978. The three day event attracts over 40,000 qualified attendees from more than 30 countries. There are over 700 exhibitors and close to 1.5 million square feet of trade show and exhibit space.

labelled “ag experts” as they are in a position to offer advice on all aspects of farming, including climate change, to farmers.

Approximately 50 expert surveys were handed out at two conference events where a high attendance of such experts was expected. One was the "Farming for Profit" conference, which was held at Moose Jaw June 22-23, 2008. Most attendees to this conference were university professors, farming organization members, other agricultural professionals, along with a few well-informed and high-profile farmers. The other was the "Agri-benchmark Cash Crop Conference", which was held in Saskatoon July 7-11, 2008. Conference attendees in this case were mostly agricultural professionals from approximately 14 countries. A total of 23 responses were collected from these two conferences.

5.2.3 Demographic Characteristics of Producer Respondents

Out of the 135 farm producers who responded to the survey, 106 were male and 28 were female. We use the following definitions: we define a farmer whose age is less than thirty as a *young farmer;* one aged thirty to fifty as an *experienced farmer;* and one over fifty as a *senior farmer*. There were 27 *young*, 42 *experienced* and 54 *senior farmers* who completed the survey. Excluding 1.5% of undefined responses (those who did not want to report their personal information), 21 farmers in the sample cultivated less than 640 acres, 81 farmers cultivated between 640 and 5120 acres, and 17 farmers cultivated farm more than 5120 acres. In terms of farm type, there are 54 grain, 9 livestock, and 54 mixed grain and livestock farmers, while the rest are unspecified. In terms of land tenure, few farmers leased all of their land (9 farmers), while the remainder either own all their land (55 farmers) or lease a portion of their land (51 farmers).

Table 5.1 reports the producer profile by age, gender and farm size. The last column in each table presents the proportion of respondent age range for each gender. The bottom row shows the proportion by respondent farm size, farm type, and ownership. Most farmers are small or medium sized: 69% of farmers cultivate 640 to 5120 acres, and 79% are male and 19% are female in this category (Table 5.1); 40% of farmers produce grains and 40% of farmers produce both grain and livestock (see Appendix 2.2: Table A8); 40% of farmers cultivate their own farm land, and 37.8% of farmers cultivate both owned land and leased land (see Appendix 2.2: Table A9).

Table 5.1: The Relationship between Producer Respondent Age, Gender and Farm Size

Gender	Age	Farm Size in Acres						% of Total Respondents
		<160 acres	160 - 640	640 - 1280	1280 - 5120	>5120	NS	
Male (n=106)		% of in Farm Size Group						
	<30	7.4%	3.7%	25.9%	18.5%	18.5%	25.9%	20.0%
	30 - 40	0.0%	20.0%	30.0%	10.0%	20.0%	20.0%	7.4%
	40 - 50	0.0%	14.3%	14.3%	57.1%	9.5%	4.8%	15.6%
	50 - 60	0.0%	10.7%	32.1%	46.4%	7.1%	3.6%	20.7%
	> 60	5.3%	10.5%	21.1%	36.8%	26.3%	0.0%	14.1%
	% of All Males	**2.2%**	**8.1%**	**19.3%**	**28.1%**	**12.6%**	**6.7%**	**77.8%**
Female (n=28)		% of in Farm Size Group						
	<30	10.0%	20.0%	20.0%	10.0%	0.0%	40.0%	7.4%
	30 - 40	16.7%	33.3%	16.7%	33.3%	0.0%	0.0%	4.4%
	40 - 50	0.0%	0.0%	0.0%	80.0%	0.0%	20.0%	3.7%
	50 - 60	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	1.5%
	> 60	0.0%	20.0%	60.0%	20.0%	0.0%	0.0%	3.7%
	% of All Females	**1.5%**	**3.7%**	**4.4%**	**7.4%**	**0.0%**	**3.0%**	**20.7%**
NS								**1.5%**
% of Total Respondents		**3.7%**	**11.9%**	**23.7%**	**36.3%**	**12.6%**	**11.9%**	**100.0%**
Note: NS=Unspecified								

Because of the relatively small farmer sample size (See section 5.2.1), there is concern as to its representativeness of the general population in terms of gender, age, farm type, farm size, and farm ownership. Accordingly, sample demographics were compared to the 2006 Census of Agriculture (Table 5.2).

As can be seen from Table 5.2, all of the *APAS* members who responded to the survey were male and most of them were between the ages 35 to 54, while 72% of the *WCFP Show* respondents were male and most of them (49.5%) were over 55 years old. In comparing the two sample groups, besides a slight over representation of males, the *WCFP Show* sample seems to reasonably represent Saskatchewan producers. The fact that the *APAS* members' sample is unrepresentative of the general farming population in terms of gender and age is not a major concern as the combined sample groups in "Total Participants" is representative of the general farming population in gender and age.

Table 5.2: Comparison of Survey Respondent Characteristics to the Census Farm Population

Indicator	**APAS**	**WCFP Show**	**Total Participants**	**Census Population of Saskatchewan Producers**
Gender (% of total sample/population)				
Male	100.0%	72.0%	77.8%	76.2%
Female	0.0%	29.9%	20.7%	23.8%
Age (% of total sample/population)				
>35	10.7%	10.3%	10.0%	13.3%
35-54	75.0%	40.2%	47.9%	64.0%
>55	14.3%	49.5%	42.1%	56.2%
Source: Author's own calculations based on survey data and Census of Agriculture 2006				

5. 3 Summary of VAS Questions

Since the VAS format was used to ask most of the questions in this study, a cross reference table that include different polar descriptors on the left end of the line and the right end of the line is provided to facilitate comparisons (Table 5.3). Also note that for the comparison between producer and expert opinion of climate change, the question number used differs slightly between the two surveys. This can be referenced in Appendix 2.1. In particular, Q1-14 and Q15-17 are from the producer survey, and Q1-14 and Q18-22 are from the expert survey.

Table 5.3 : Explanation of Labels used in VAS Questions

No.	Question	0	5	10
1	Do you think that global climate is changing?	No Change	Moderate Change	Considerable Change
2	Do past extreme weather events affect your opinion?	No Effect	Moderate Effect	Considerable Effect
4	What will be the overall effect of climate change on Canadian prairie farm production?	Net Cost	No Change	Net Benefit
5	How long do you think climate change will take before it begins to seriously affect your life?	Immediately	30 years	60 years
6	Do you believe that global climate change is mostly caused by human activities?	No Effect	Moderate Effect	Considerable Effect
7	How much do *"climatologists or scientists"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
8	How much do "environmental groups" influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
9	How much do *"newspaper and magazines"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
10	How much do *"radio and television"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
11	How much do *"internet/world wide web"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
12	How much do *"friends"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
13	How much do *"family members"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
14	How much the *"others"* influence your climate opinion?	No Influence	Moderate Effect	Considerable Influence
15	What do you think the experts are saying about climate change?	No Change	Moderate Change	Considerable Change
16	What do you think the experts are saying about the effect of climate change?	Net Cost	No Change	Net Benefit
17	What do you think the experts are saying about how long it will take before climate change will seriously affect the Canadian Prairies?	Immediately	30 years	60 years
18	Is the general public in Canada concerned about climate change?	No Concerned	Some Concern	Highly Concerned
19	How are the media currently portraying the issue of climate change?	Poor Job	Reasonable Job	Good Job
20	Do you think Canadian farmers are concerned about climate change?	No Concern	Some Concern	Considerable Concern
21	How do farmers perceive the net benefits or costs of climate change on Canadian parities?	Net Cost	No Change	Net Benefit
22	How long do you think farmers will say that it would take before climate change begins to seriously affect the Canadian prairies?	Immediately	30 years	60 years

* Question 3 is a discrete choice type question and it is not included in this table.

5.4 Producer Attitudes towards Climate Change

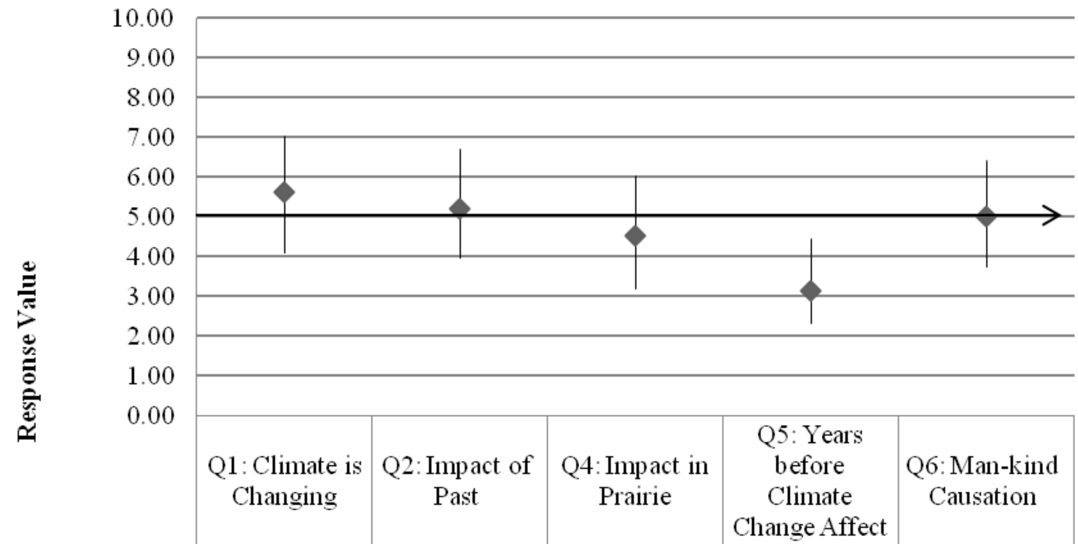
The primary objective of this section is to quantify producer opinions towards climate change and then to compare the differences between producer and expert opinions. The questionnaires are divided into three sections: 1) opinions towards climate change; 2) the perceived opinion of the other group; and 3) the influence power of different media sources in shaping participant opinions. The producer survey has 17 questions in total. The three sections (Q1-6, Q7-14, and Q15-17) are discussed in detail in sections 5.4.1-5.4.3.

5. 4.1 Climate Change and Its Underlying Causes (Q1-6)

In this section, the responses to those questions related to climate change, Q1-Q6, and a brief graphic analysis for Q1-2 and Q4-6 are presented in Figure 5.1 using high-low and average responses. A more complete analysis is presented in Appendix Table 10. Using the extreme values that form the range of MLV values, the vertical lines represent the average lower and upper bound value of producer MLV. The "diamonds" represent the mean of MLV. As Table 5.3 indicates, a value of "5" represents moderate opinion or neutral opinion (based on different questions). Using Figure 5.1, producer opinions can be summarized as follows:

> 1) On average, producer uncertainty levels are similar in these five questions (value range from 1.51 to 2.16). Question one, "do you think climate is changing" had the highest uncertainty range value (2.16) and question 5 - "how long do you think climate change will take to seriously affect your life" had the lowest uncertainty range value (1.51).
>
> 2) Based on MLV values, most producers believe that climate is changing somewhat; that past extreme whether events have somewhat affected producers opinion; that the impact to Canadian Prairies are net cost and this impact might take 18 to 20 years to materialize; and human activities take some part of responsibility for the cause of climate change.

The detailed description for each question is further discussed below.



	Q1: Climate is Changing	Q2: Impact of Past	Q4: Impact in Prairie	Q5: Years before Climate Change Affect	Q6: Man-kind Causation
Mean of Lower limit	4.09	3.97	3.18	2.32	3.75
Mean of Upper Limit	7.01	6.70	6.02	4.43	6.41
◆ Mean of MLV	5.62	5.20	4.51	3.13	5.00

Response Value	**Indicator**				
0 =	**No Change**	**No Effect**	**Net Cost**	**Immediately**	**No Effect**
10 =	**Considerable Change**	**Considerable Effect**	**Net Benefit**	**60 years**	**Considerable Effect**

Figure 5.1: Mean Value of Producer *MLV* and *R*, Q1, 2, 4-6

(diamond = *MLV*, *R* is indicated by the vertical line)

The first question elicits producer general beliefs about climate change. Producers were asked to rate their opinion from "No change" to" Considerable change" in a horizontal line. "No change" is defined as normal weather variation, or variation as a part of a cycle that has occurred throughout earth's history. "Considerable change" means an unusual shift in climate. If a producer believes that one or more of the following effects hold: warmer and fewer cold days and nights; more frequent heat waves, heavy precipitation events, droughts over larger areas;

more intense tropical cyclone, hurricanes and tornadoes; higher sea levels etc., he/she would mark the answer as "considerable change".

The frequencies of producer responses to the first question are displayed in the following histogram, (Figure 5.2). Among 135 producers, none believe that there is no climate change, while six producers (0.04%) believe that climate has changed considerably. Using a middle point of 5 as a dividing line, there are 24% (32) of producers who think climate is changing but not too much (response value = 1 to 4), and 65% (87) of producers think that there will be considerable climate change (response value = 6 to10).

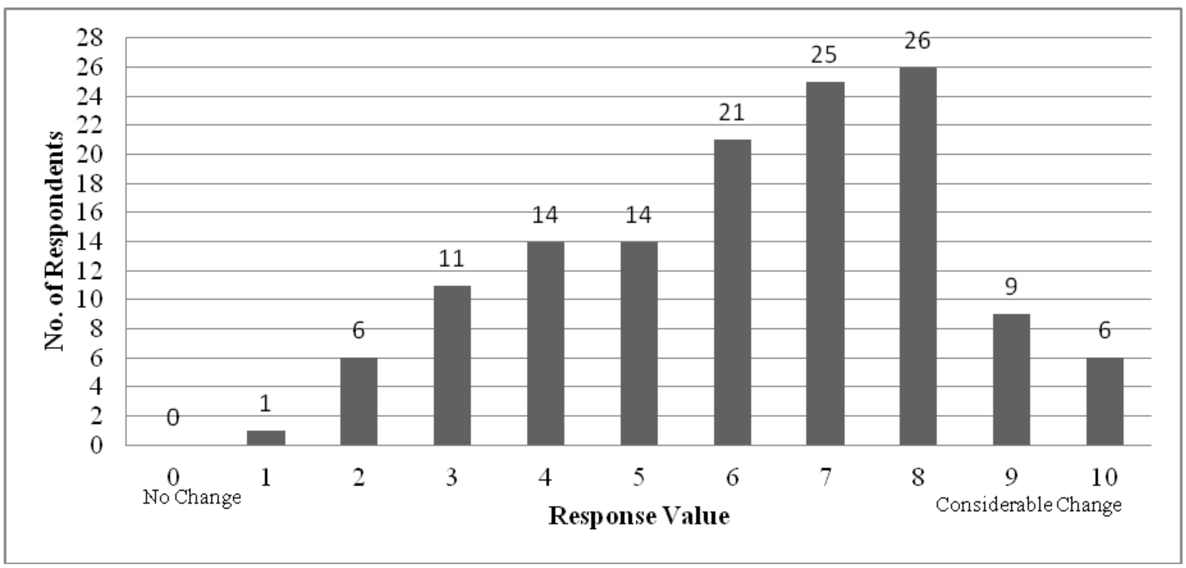


Figure 5.2: Frequency of Producer Responses to Q1, "Do you think climate is changing?"

The second question evaluates the impact of recent extreme weather events on producer opinions. It is expected that recent extreme events would cause greater certainty on climate change opinion. As shown in Figure 5.3, many producers believe that recent extreme weather events indicate climate change, or these events validate that climate is changing. A total of 28% (38) of producers have been slightly affected by extreme events (whose response value is less than 5), 56% (76) of the producers believe in a relatively larger change because of past extreme events. The remaining 15% (20) of producers reported moderate change.

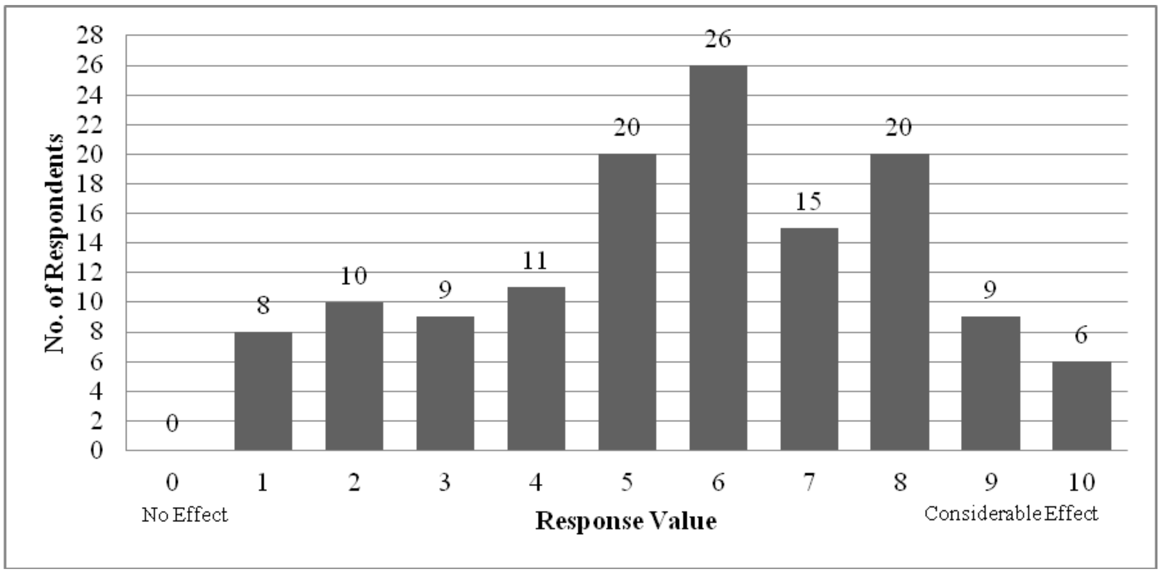


Figure 5.3: Frequency of Producer Responses to Q2,

"Do past extreme weather events affect your opinion?"

The third question is an extension of the previous question: it asks how much producers have changed their climate opinion in the past 10 years if their climate opinion was affected by extreme weather. The frequencies of producer response for question three are displayed in the following histogram graph (Figure 5.4). Unlike other questions, producers were asked to give a discrete choice: 1 (no change), 2 (small change), 3 (moderate change), and 4 (large change). Excluding producers who did not answer this question (24 of total), 7% (9) of producers did not change their climate opinion in the past 10 years, 41% (49) of producers changed their opinion slightly, 43%(51) of producers had moderate opinion change towards climate, and 7% (10) of them had significantly changed their opinion.

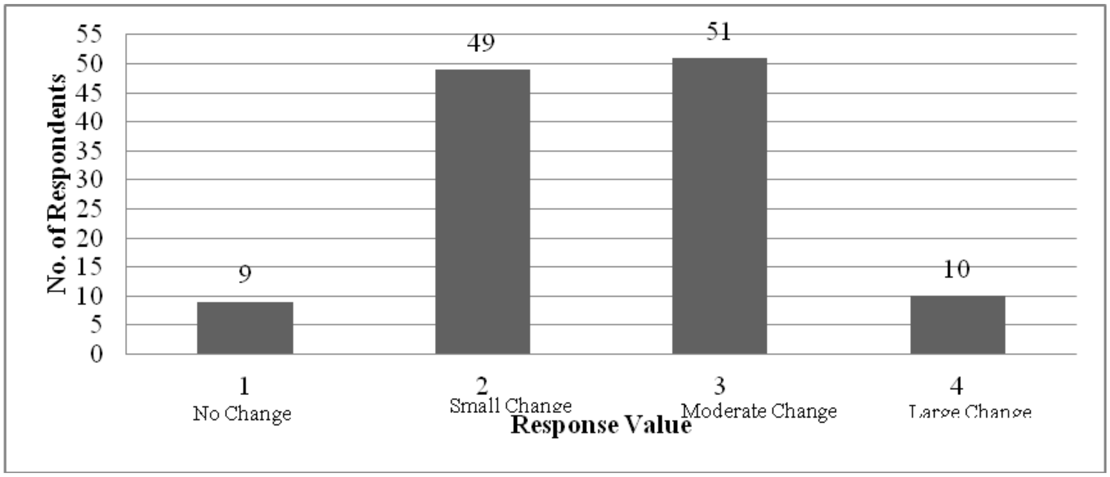


Figure 5.4: Frequency of Producer Responses to Q3,

"How much have you changed your climate opinion in the past 10 years?"

The fourth question asked them to provide their opinion as to the impact of climate on Canadian prairie farm production, if they believe that climate is changing. In this question, the negative impacts of potential climate change are described in terms of "decreasing water availability", "increasing amphibian extinction" and "species range shifts". The positive impacts of potential climate change are described as "providing a longer growing season", "allowing new markets and new crops". The frequency of producer responses to this question is displayed in Figure 5.5. The middle point *“5”* in this question means "no change", a lower end means an "extreme net cost" and an upper end means "extreme net benefit". None of the respondents reported holding the opinion of either "extreme net cost" or "extreme net benefit". Assuming that the middle point (5) represents an opinion of no effect, 36% (49) of producers think climate change would impose a net cost to Canadian prairie farm production, 39% (52) of producers think there would be net benefits, and 24% (32) of producers think there will be no effect to Canadian farming production at all.

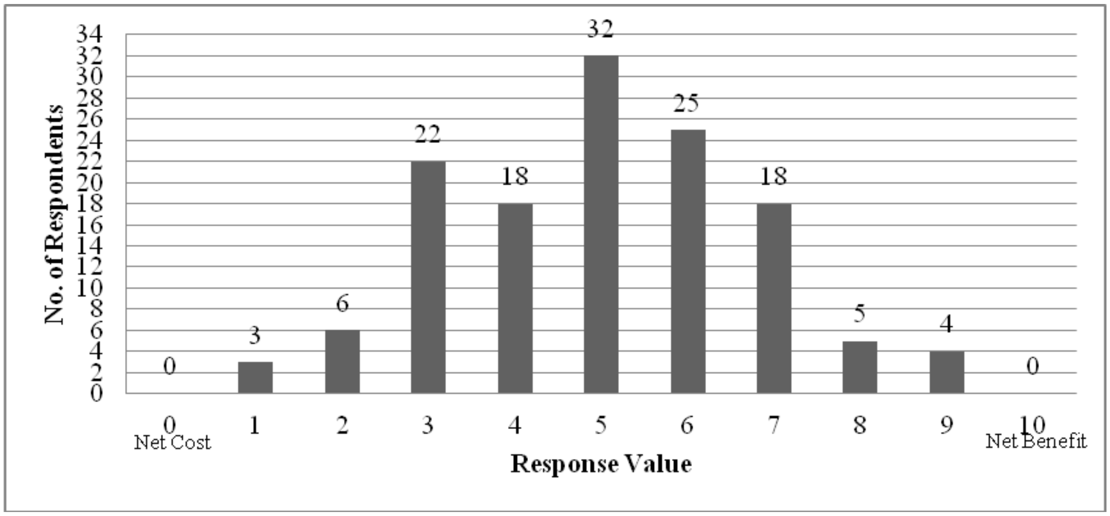


Figure 5.5: Frequency of Producer Responses to Q4,

"What do you think the effect of climate change is on Canadian prairie farm production?"

In the fifth question, producers were asked to indicate how long it will take before climate change begins to seriously affect human life. The scale ranges from "immediately" to "sixty years". The frequencies of producer response for question 5 are displayed below (Figure 5.6). None of the respondents indicated that they believe climate change will seriously affect their personal or business life immediately, nor do many producers (16 out of total participants) think the adverse impact will happen after 40 years. A majority of producers (89 producers, 66%) think the serious effect will take place in 5 to 25 years.

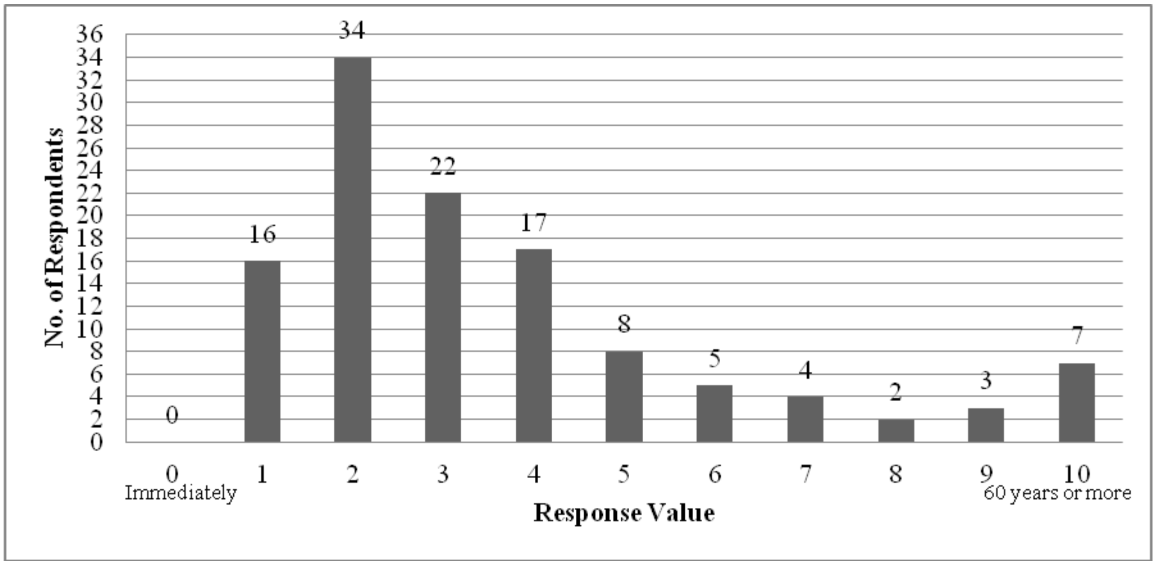


Figure 5.6: Frequency of Producer Responses to Q5,

"How long do you think it will take before climate change begins to seriously affect your personal or business life?"

Question 6 elicits producer opinion on the relationship between climate change and human activities. Again, "0" indicates human activity is not associated with climate change, "5" indicates human activity has a moderate effect on climate change, and "10" indicates a considerable effect (Figure 5.7). All survey respondents think that human activity is responsible for climate change to some extent. Using a middle point of 5 as the dividing line, 35% (47) of producers think that human activity is having some or little impact (response value less than 5); 17% (23) of producers think that human activity has average impact, and 48% (64) of producers think that human activity has considerable impact (response value greater than 5).

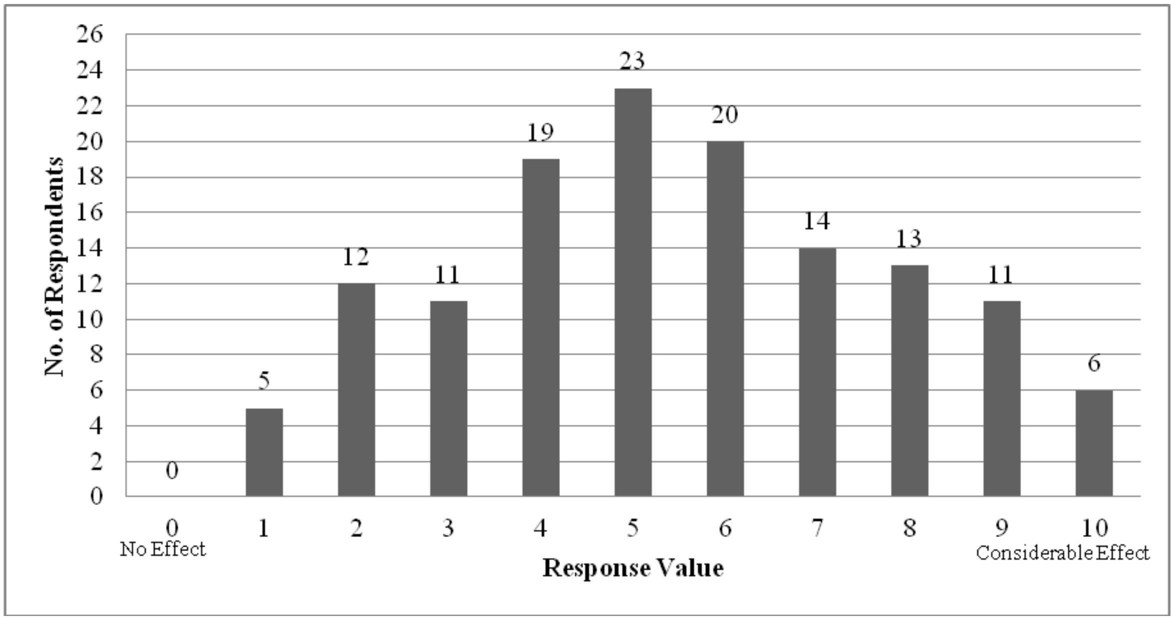


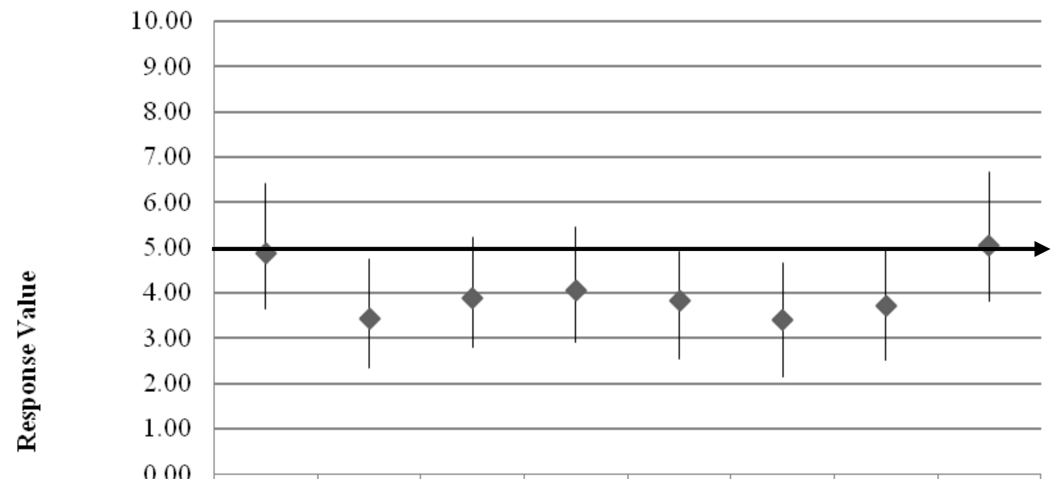
Figure 5.7: Frequency of Producer Responses to Q6,

"Is global climate or 'average weather' change mostly caused by human activities?"

5.4.2 Influence of Information Source on Producer Opinion (Q7-14)

The influence of different information sources in shaping producer opinions is asked in questions 7 to 14. Information sources include: "Climatologists/Scientists", "Environmental Group", "Newspaper and Magazines", "Radio and TV ", "Web", "Friends", "Family Members", and "Other information source". The responses to these eight questions related to information sources for climate change are summarized in Appendix Table A11. Based on the mean values of *MLV*, "Climatologist/Scientists" and "Radio and TV"[19] have relatively greater influence on producers, while the "Environmental Group" and “Friends” have the least influence.

[19] According to Figure 5.8, "Other information source" seems have greatest influence on producers. However, since there are not many producers responses in this category, the result is inaccurate and is excluded from discussion.



	Q7: "Climatologists/Scientists"	Q8: "Environmental Group"	Q9: "Newspaper and Magazines"	Q10: "Radio and TV"	Q11: "Web"	Q12: "Friend"	Q13: "Family Members"	Q14: "Other" Influence
Mean of Lower limit	3.65	2.35	2.79	2.90	2.53	2.16	2.52	3.81
Mean of upper limit	6.41	4.75	5.22	5.45	4.91	4.67	4.99	6.68
◆ Mean of MLV	4.87	3.44	3.89	4.05	3.84	3.40	3.71	5.03

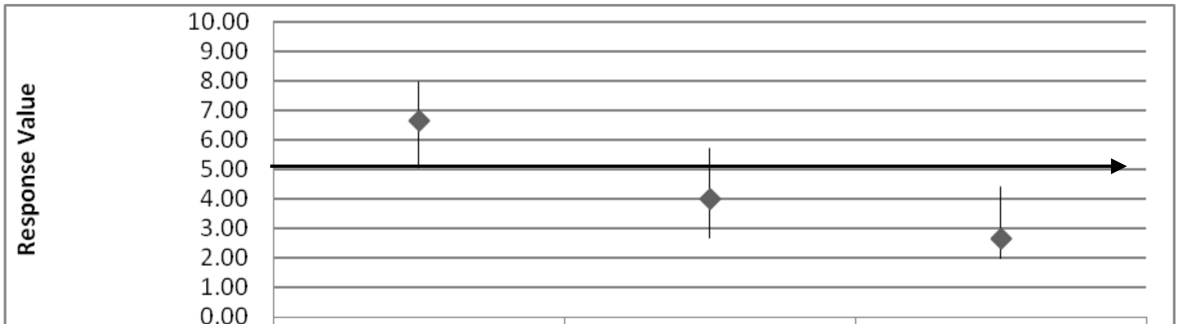
Figure 5.8: The Influence of Others on Producer Opinion (Q7-14)

(diamond = *MLV*, *R* is indicated by the vertical line)

0 indicate "No Influence" and 10 indicate "Considerable Influence"

5.4.3 Producer Perceptions of Expert Opinions (Q15-17)

In this section, the mean MLV of the three related questions measuring producer perspective on expert climate change opinions are presented in Figure 5.9, while a summary of statistics for these responses is shown in Appendix Table A12. The detailed description for each question is further discussed below.



	Q15: Experts on Climate Change	Q16: Experts' View on Impact	Q17: Experts' View on How Long
Mean of Lower limit	5.04	2.66	1.99
Mean of upper limit	7.96	5.69	4.42
◆Mean of MLV	6.65	4.01	2.65

Figure 5.9: Producers Perception of Expert Opinions (Q15-17)

(diamond = *MLV*, *R* is indicated by the vertical line)

Similar to the first survey question, producers are asked to assess their perception as to expert opinion on the level of climate change (Question 15). The frequency of producer responses on "Producer Perspectives on Expert Climate Views" is shown below (Figure 5.10). A majority of producers (75%) believe that experts believe more in the existence and effects of climate change than they do.

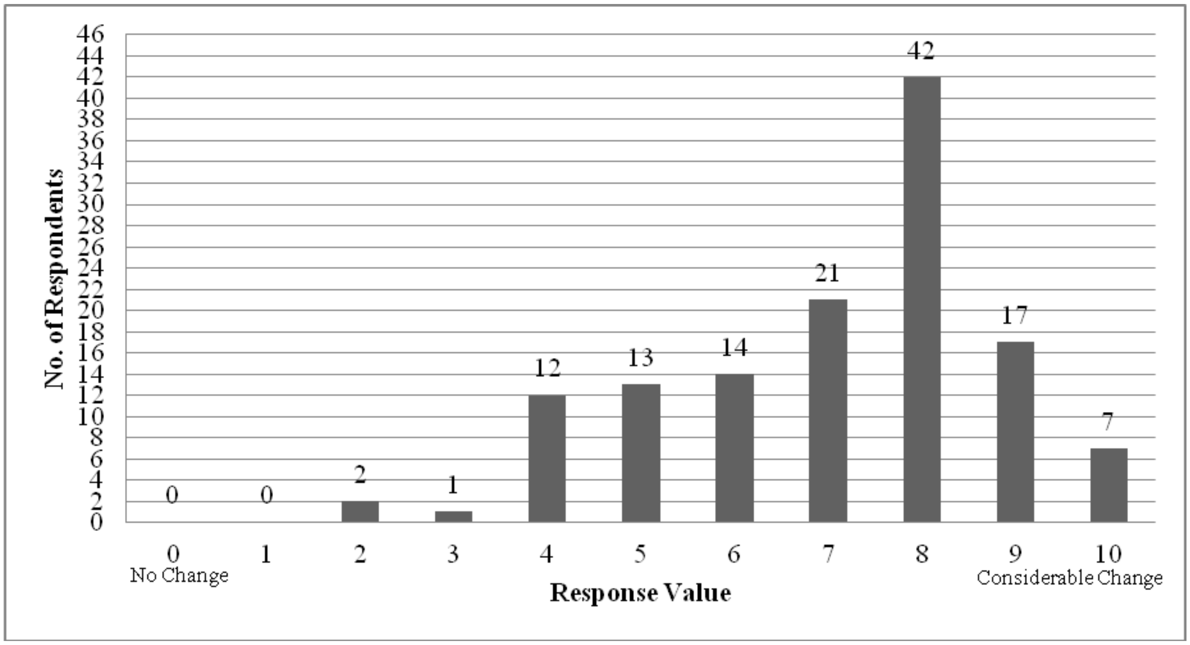


Figure 5.10: Frequency of Producer Responses to Q15,

"What do you think the experts are saying about climate change?"

This section reports producer views on what experts think about climate change effects (Figure 5.11). Only 27% (36) of producers think experts believe that Canadian farming would not be affected by climate change; 43% (58) of producers think experts assert there would be a net cost to Canadian farming; and 25% (33) of producers think experts assert that there will be a net benefit to Canadian farming. It is not surprising that more producers perceive that experts believe there will be a net cost as most producers hold that experts overemphasize climate change effects.

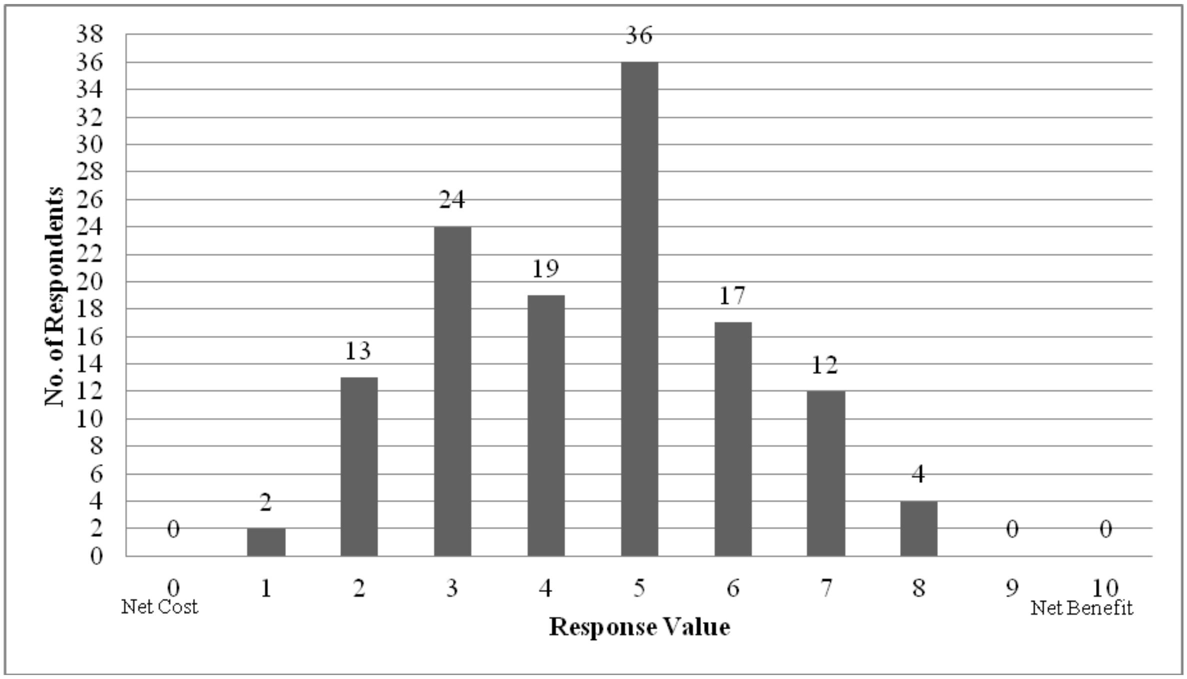


Figure 5.11: Frequency of Producer Responses to Q16,
"What do you think the experts are saying about the effect of climate change?"

Similar to the previous two questions, Question 17 asks what producers think about expert opinion concerning <u>how long</u> it will take before climate change will begin to seriously affect the Canadian Prairies. The frequency of "producers perspectives on expert views on how long" is shown in Figure 5.12. Twenty four producers did not complete this question, which indicates they do not know (or perhaps don’t care) about expert opinions for this particular question. For the remaining 109 producers who completed the question, 89 farmers (82%) think experts believe it will take less than 25 years for climate change to have serious repercussions for the Canadian Prairies.

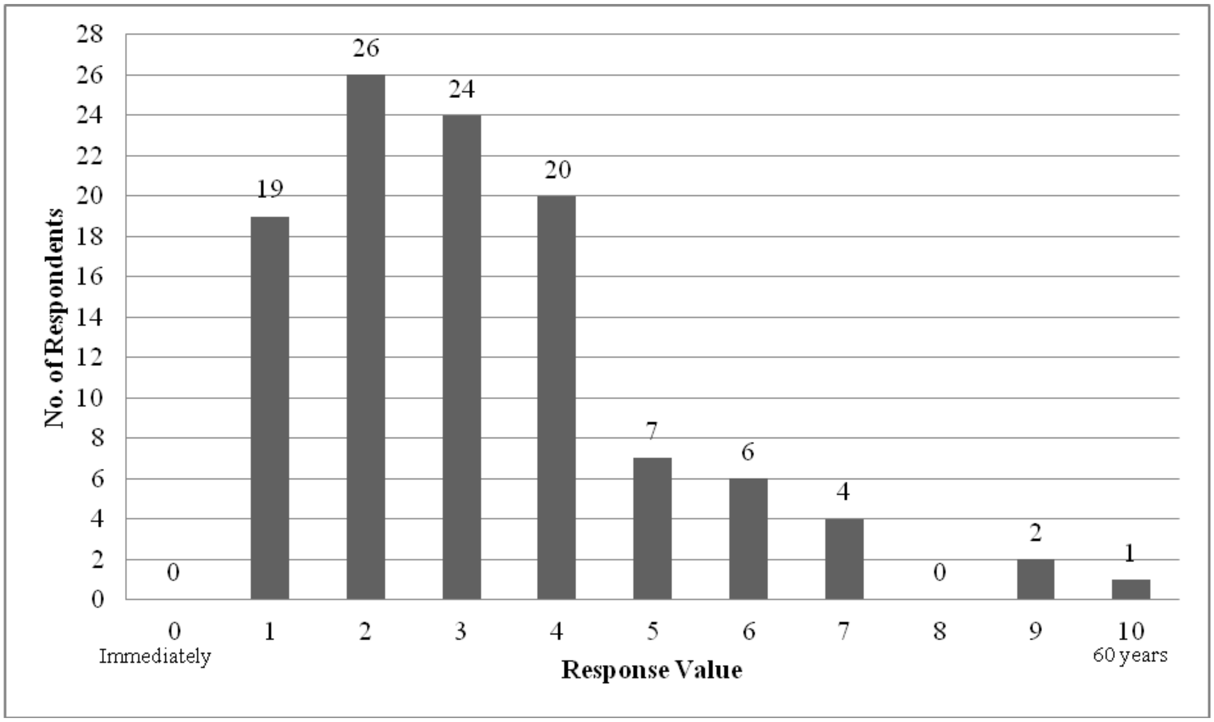


Figure 5.12: Frequency of Producer Responses to Q17,
"What do you think the experts are saying about how long it will take before climate change will seriously affect the Canadian Prairies?"

5.5 Expert Climate Change Opinion

Similar to the producer survey, the expert survey also included three parts. There are six questions (Q1-6) which evaluate expert opinion towards climate change, eight questions (Q7-14) about where they obtain their climate change information, and five questions (Q18-22) on their perspectives on producer opinion. Further information on expert mean *MLV* values and uncertainty ranges, R, are presented in Figures A1-5 (Appendix 2.4). The primary purpose of this section is to provide a general description of expert opinion.

In general, the agricultural expert mean responses are mostly above or close to the moderate point. They believe that climate will change considerably; that it will have a net cost to society and they think that human activity has a significant impact on climate change. Similar to farmers, agricultural experts rely on "Radio and TV" to obtain information on climate change, and rely less on information provided by any so-called "environmental group". They also think that government and producers are much less concerned about the impact of climate change than they should be.

This section compares expert opinions to producer opinions. The mean value of MLV and R of producers and experts are presented for key questions in Table 5.4 and in more detail in Figures 5.13 (MLV) and 5.14 (R values). In order to give a general description of group similarity, an ANOVA is conducted assuming case independence, normality and similar group variances (Table 5.5). In general for many question, expert opinion MLVs are higher and statistically different for many questions. Experts are more likely to feel strongly that climate is currently changing (Q1: 6.52 versus 5.62); that mankind is the source of change (Q6: 6.34 versus 5.00); and that they are more likely to be influenced by media sources (Q9-10), climatologists or scientists (Q7), friends (Q12) and family (Q13) more readily than producers. However, there is no statistical difference in, "past extreme event impact" (Q2) or the "length of time before climate change affects your life" (Q5).

In a similar fashion, mean producer and expert uncertainty level (*R*) are compared in Figure 5.14 and the statistical results are displayed in Table 5.5. Interestingly, when compared to producers, agricultural experts display greater uncertainty in questions 1, 4, 5, 6, 8 10-13. This may reflect either the greater diversity in agricultural experts or more openness to a range of possibilities.

The following sections compare group perceptions as to the other group's opinions (Table 5.4).[20] For the question, "Do you think that global climate is changing?" (Q1/Q15), producer perception of expert opinion is almost the same as the experts' own opinion (6.65 versus 6.52) and there is no statistical difference in the MLVs. However, experts seemed to have underestimated producer response to this issue (4.55 versus 5.62), indicating that producers have a more accurate perception about experts than experts do about producers.

In comparing cross group perception for the question, "What do you think will be the overall effect of climate change on Canadian prairie farm production?" (Q2/Q16), experts correctly assessed producer actual beliefs (4.51). However, producers seemed to have under-estimated expert opinion on the same issue (4.01 versus 4.75), meaning they perceive that experts believe there is a lower net cost to climate change than they actually do.

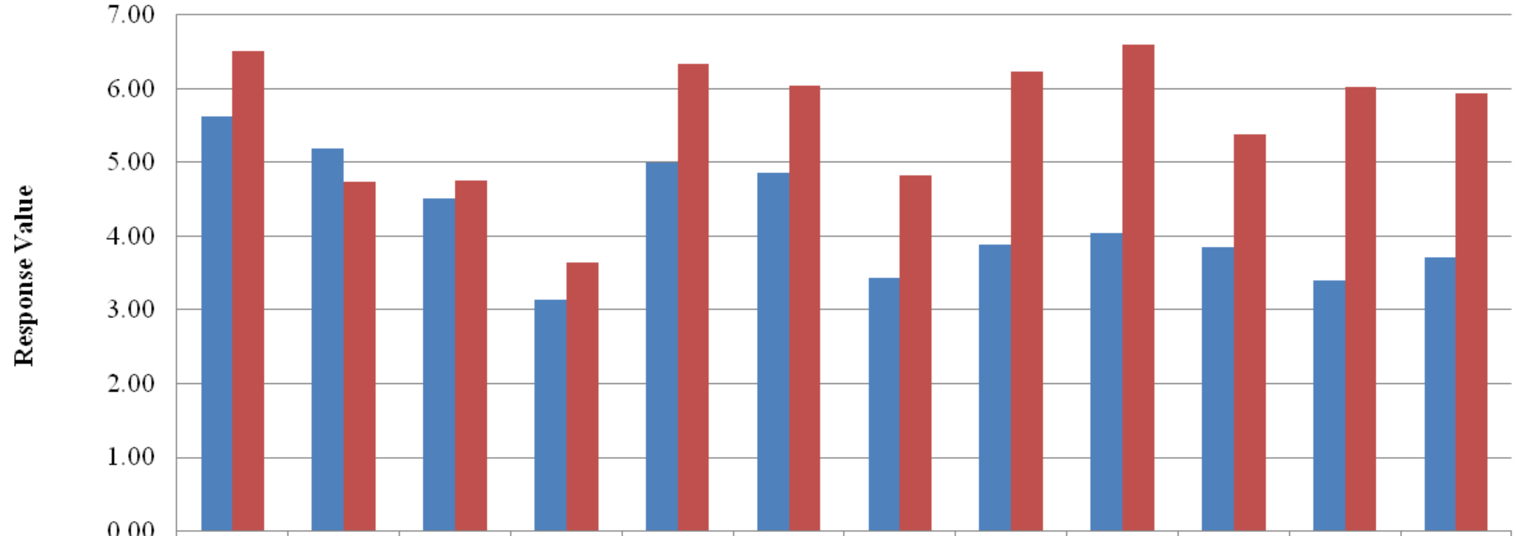
In assessing the other group's opinion for the question "How long do you think it will take before climate change begins to seriously affect your personal or business life, requiring you to make changes and adapt?" (Q5/Q17), experts more correctly perceive producer beliefs (3.34 versus 3.13), than producers perceive expert opinion (2.65 versus 3.65).Producers generally assessed experts as holding a belief that the time to change is shorter than their true beliefs.

[20] Producer questions: Q15 - Q17 correspond to expert questions Q20-22, respectively.

Table 5.4: Comparison of Producer and Expert Opinion and Their Perception of the Other Group's Opinions

Producer's Opinion	Expert's Opinion	Producer's perception as to Experts	Expert's Perception as to Producers
Q1/Q15: Climate is Changing			
5.62	6.52	6.65	4.55
Q2: Do Past Event Affect Your Opinion			
5.20	4.73	na	na
Q4/Q16: Climate Impact to Prairies			
4.51	4.75	4.01	4.51
Q5/Q17: Number of Years before Change			
3.13	3.65	2.65	3.34
Q6: Human Activities Causation			
5.00	6.34	na	na

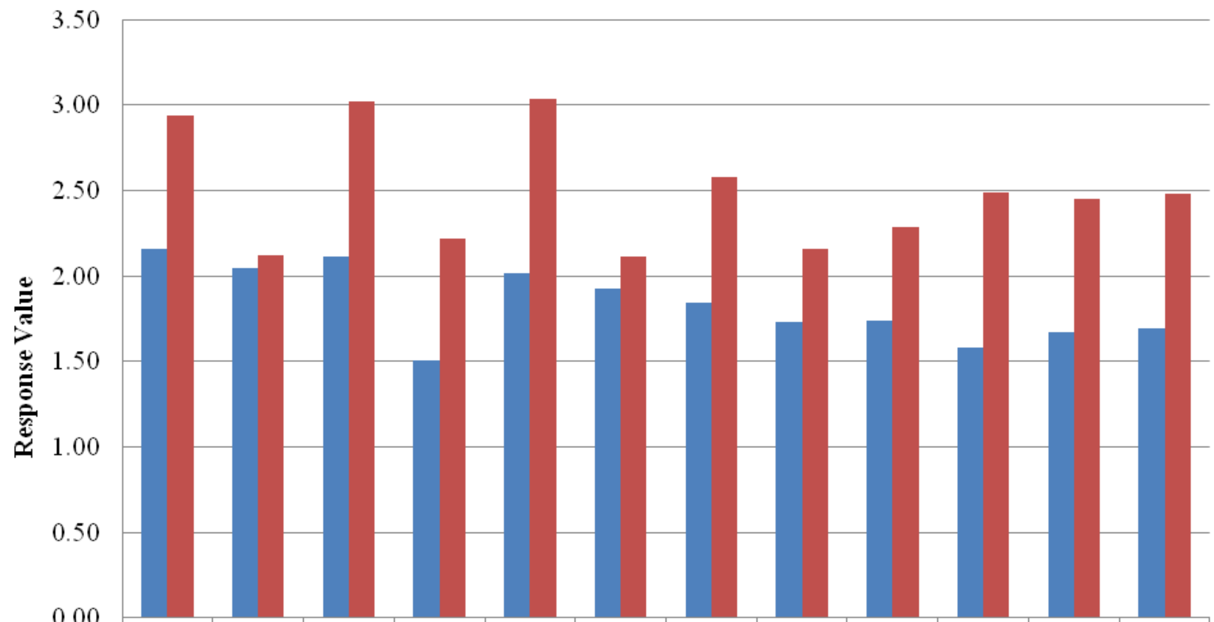
* All numbers are mean of *MLV;na means not asked*



	Q1: Climate is Changing	Q2: Impact of Past	Q4: Impact in Prairie	Q5: Years before Climate Change Affect	Q6: Man-kind Causation	Q7: "Climatologists/Scientists"	Q8: "Environmental Group"	Q9: "Newspaper and Magazines"	Q10: "Radio and TV"	Q11: "Web"	Q12: "Friend"	Q13: "Family Members"
Producer Response	5.62	5.20	4.51	3.13	5.00	4.87	3.44	3.89	4.05	3.84	3.40	3.71
Experts Responses	6.52	4.73	4.75	3.65	6.34	6.05	4.82	6.23	6.60	5.37	6.02	5.93

Response Value	Indicator											
0 =	No Change	No Effect	Net Cost	Immediately	No Effect	No Influence	No Influence	No Influence	No Influence	No Influence	No Influence	No Influence
10 =	Considerable Change	Considerable Effect	Net Benefit	60 years	Considerable Effect	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence

Figure 5.13: A Comparison of Producer and Expert Mean *MLV* Responses, Q1-Q13



	Q1: Climate is Changing	Q2: Impact of Past	Q4: Impact in Prairie	Q5: Years before Climate Change Affect	Q6: Man-kind Causation	Q7: "Climatologists/Scientists"	Q8: "Environmental Group"	Q9: "Newspaper and Magazines"	Q10: "Radio and TV"	Q11: "Web"	Q12: "Friend"	Q13: "Family Members"
Producer Response	2.16	2.05	2.11	1.51	2.02	1.93	1.84	1.73	1.74	1.58	1.67	1.69
Experts Responses	2.94	2.12	3.02	2.22	3.03	2.11	2.58	2.16	2.28	2.49	2.45	2.48

Response Value	Indicator											
0 =	No Change	No Effect	Net Cost	Immediately	No Effect	No Influence	No Influence	No Influence	No Influence	No Influence	No Influence	No Influence
10 =	Considerable Change	Considerable Effect	Net Benefit	60 years	Considerable Effect	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence	Considerable Influence

Figure 5.14: A Comparison of Producer and Expert Mean *R*, Uncertainty Range, Q1-Q13

Table 5.5: An ANOVA Comparison of Producer and Expert MLV and R Responses

Producer Survey Question		P - value	
No	Description	MLV	R
1	Do you think that global climate is changing?	0.07	0.02
2	Do past extreme weather events affect your opinion?	0.42	0.82
4	What will be the overall effect of climate change on Canadian prairie farm production?	0.02	0.02
5	How long do you think climate change will take before it begins to seriously affect your life?	0.36	0.01
6	Do you believe that global climate change is mostly caused by human activities?	0.01	0.00
7	How much do "climatologists or scientists" influence your climate opinion?	0.01	0.61
8	How much do "environmental groups" influence your climate opinion?	0.02	0.07
9	How much do "newspaper and magazines" influence your climate opinion?	0.00	0.20
10	How much do "radio and television" influence your climate opinion?	0.00	0.10
11	How much do "internet/world wide web" influence your climate opinion?	0.01	0.01
12	How much do "friends" influence your climate opinion?	0.00	0.02
13	How much do "family members" influence your climate opinion?	0.00	0.02
15	What do you think the experts are saying about climate change?	0.48	0.03
16	What do you think the experts are saying about the effect of climate change?	0.00	0.58
17	What do you think the experts are saying about how long it will take before climate change will seriously affect the Canadian Prairies?	0.20	0.00

MLV is most likely value and R is their indicated response range of likely values

Comparisons are based on a single factor analysis of variance. The P-value is the probability that there is no difference between the producer and expert groups. Statistical tests are based on the F test.

5.6 Classification of Producer Type Based on MLV Response Asymmetry

An advantage of the circle technique used here to measure producer uncertainty is its flexibility and its ability to characterize varying degrees of MLV response asymmetry [21]. This advantage is best reflected when examining the key question - "*Do you think climate is changing?*" The asymmetries in uncertainty of the lower and upper bound of MLV are displayed in Figure 5.15.

[21] An asymmetric response is identified here as producers exhibiting asymmetric uncertainty of negative ("upside uncertainty") and positive ("downside uncertainty"). For example, some producers may only mark X (their best guess) in responding the survey question and some may only mark a circle (uncertainty).

Here, the longitudinal coordinates represent response values from 0 (no climate change) to 10 (considerable climate change), and the horizontal coordinate represents participant ID's from 1 to 135. In this graph, the diamond represents respondent *MLV*s and the vertical lines indicate the range of uncertainty.

Given the their MLV and the uncertainty range responses in Figure 5.15, opinions can be evaluated based on: 1) a single-valued *MLV*; 2) a range value R that indicates where *MLV*s will likely fall (the length of vertical lines); 3) an upper value *U* (the distance between 0 and upper end of a line segment); and 4) a lower value *L* (the distance between 0 and lower end of a line segment). In addition, to capture varying degrees of asymmetric response, the following variables are created: 1) expected mean of an elicited range R, which is the average of U and L; 2) downside uncertainty (the distance between the triangle and the lower end of a line segment); and 3) upside uncertainty (the distance between the triangle and the upper end of a line segment). In addition, a variable that measures asymmetry in uncertainty about the lower end of the range versus the higher end B is created, and the formula is presented in 5.6.1.

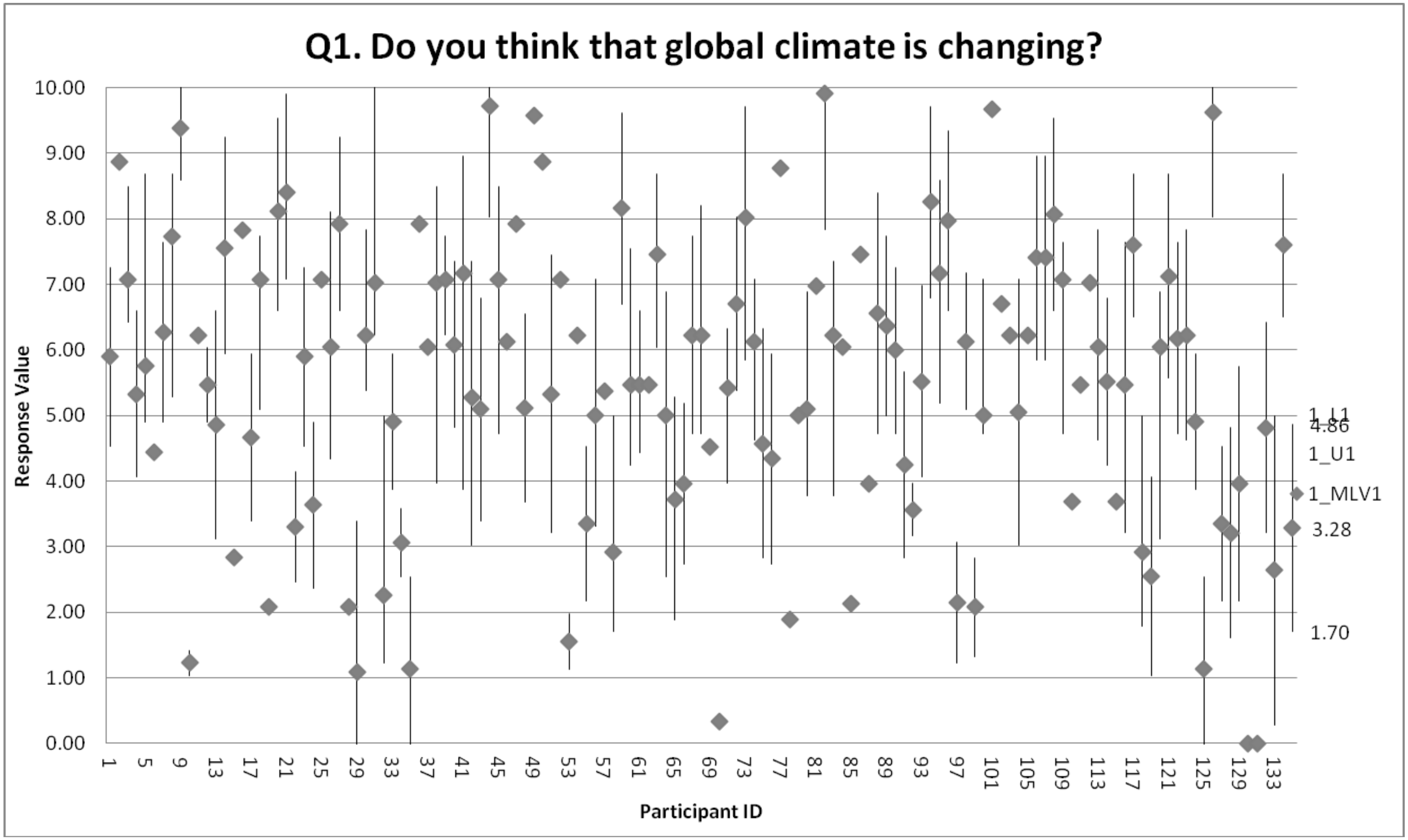


Figure 5.15: Individual Producer Response to "*Do you think climate is changing*?

(diamond = *MLV*, *R* is indicated by the vertical line)

5.6.1 Uncertainty Type Definitions

Four variables can be constructed based on responses to Q1: *MLV*, *U* (upper limit), *L* (lower limit), and *R* (range) represents the distance between the lower and upper bounds. A unique aspect of the data is the elicitation of a range of respondent plausible values as well as the respondent's most likely value. While the range is useful in assessing respondent uncertainty another aspect is their estimate of the relative upside/downside uncertainty. Accordingly, a fifth variable is constructed measuring the relative asymmetry response bounds: B[22].

Based on farmers' responses to question 1, producers are grouped based on the certainty about their response to Q1; according to the values of B & R.

> C*ertain producers:* If B=0 and R=0. This means that these producers are very confident in their opinion.
>
> *Uncertain producers:* If B = Null and R≠0. These participants did not mark a single *MLV*, and therefore we consider them to be very uncertain about the issue.
>
> *Producers with symmetric responses:* If B=0 but R≠0. This type of participant has their *MLV* centered.
>
> *Producers with uncertainty in upper bound:* If B>0 and R≠0. These participants have their *MLV* towards the lower end of the range. This group has concern about the *upside uncertainty*.
>
> *Producers with uncertainty in lower bound*: If B<0 and R≠0. This type of participant has their *MLV* towards the upper end of the range. This group has concern about the *downside uncertainty.*

[22] B is not statistical in nature but only a numerical value created to assess asymmetric opinion uncertainty.

5.6.2 Producer Classification Based on Bound Symmetry

Respondents are assigned to one of five groups: Certain, Uncertain, Symmetric, Upside Uncertainty, and Downside Uncertainty according to bounds symmetry (Table 5.6 and in greater detail in Appendix Tables A4-7). Somewhat surprisingly, there are a relatively large number of *certain producers:* 27% (36). There are 51% (69) of producers who have *symmetric* uncertainty. Interestingly, there is the same number of producers, 10% (14), falling into each of the *Upside* and *Downside Uncertainty* groups. The *MLVs* elicited from *Upside Uncertainty group* are closer to the lower bound of the range than to the upper bound. Everything else being equal, this group of farmers appears more likely to accept climate change mitigation policies as they perceive a possibility of considerable change in climate as well as a need for policies developed to cope with such change. In the case of the *Downside Uncertainty* group, their *MLV* is relatively closer to the upper bound of climate change but climate change could be much lower (downside uncertainty). Everything else being equal, it can be inferred that this type of respondent would likely be very cautious in accepting climate change mitigation policies as they would not be surprised by considerably lower climate change and its associated effects.

There are only two respondents who only indicated a range and did not indicate a *MLV*. Those producers are identified as *uncertain producer*, and they will be excluded from further analysis because of small group size.

In terms of asymmetry of response, caution must be used in interpreting producer respondents as their potential reaction to government policies depends upon both their *MLV* as well as their *B* values. Likewise, in term of social influence theory, the relative degree of uncertainty may be more important than the relative asymmetry.

Table 5.6: Producer Classes Based on Bounds Symmetry

Producer Response Type	Number	Percentage
Certain	36	26.7%
Uncertain	2	1.5%
Symmetric	69	51.1%
Upside Uncertainty	14	10.4%
Downside Uncertainty	14	10.4%
Total Producers	135	100.0%

5.6.3 Relationship between Producer Responses and Socio-Demographic Characteristics

Producer demographic characteristics are posited to be associated with different asymmetric responses. Multinomial logit regression analysis was used to examine the relationship between the categories of producer responses and socio-demographic profile of each group, such as age, gender, farm size, and farm type. In fact, none of the demographic variables are significant, regardless of two- or three- group producer classifications (see Appendix 2.6). Therefore, from this survey there is no evidence that producer age, gender, farm type, size, or tenure can explain individual asymmetric response.

5.7 Summary and Conclusions

Producer and expert opinion towards climate change are reported in this chapter. In comparing the two groups, experts believe, in general, that there is a greater degree of climate change than producers but they also allow for a greater degree of uncertainty than do producers. Experts think the public and producers are much less concerned about the impact of climate change than they should be. At the same time, producers think experts have over-stated the issues related to climate change, while experts think producers have not paid enough attention to the issue.

CHAPTER SIX: CLUSTER ANALYSIS OF PRODUCER OPINION

6.1 Introduction

The purpose of this chapter is to investigate sources of heterogeneity in producer climate change opinions and to classify producers into different groups using clustering analysis. In order to better understand climate change beliefs, clustering analysis is used to group the entire sample into a few clusters, and descriptive labels are assigned to each cluster based on their distinctive characteristics. In addition, the relationship between cluster membership and underlying socio-demographic or farm characteristics is examined using regression analysis.

6.2 Determining the Number of Clusters

According to Norušis (2000) there is no theoretically correct number of clusters as it depends upon a number of factors. Because the correct number of groups is unknown, two different procedures are used (K-means cluster and two-step cluster) in evaluating the number of clusters by varying the number from two to fifteen groups.

Two relatively simple analytical ways of establishing the appropriate number of clusters are Mardia's rule of thumb, and the information criterion measure.[23] Kanti Mardia (1979) suggested a simple rule of thumb for the choice of the number of clusters, where *n* is the number of objects or data points and *k* is the number of groups.

[23] A third way to estimate a better cluster number is to examine the percentage of variance explained as a function of the number of clusters, and then choose the number of clusters so that adding another cluster adds little information (Ketchen & Shook 1996).

This approach is not appropriate since our responses are continuous, meaning there are potentially an infinite number of data points. However, to find a very rough approximation, the following heuristic might be appropriate. Using only the *MLV* responses and assuming that there are approximately 10 discrete responses, the number of objects is the number of questions (6) times the number of possible responses (10) or 60. This would suggest five clusters as a reasonable number. Even so, this is likely too generous as not all combinations are observed among the various questions, so the number of points is much fewer—approximately 18 or fewer. The latter would suggest only two or three clusters.

A second approach is the information criterion approach based on two-step clustering outcomes. The information criteria can be based on Akaike information (AIC), Bayesian information (BIC)[24], or the Deviance information criteria. In these criteria, the optimal number of clusters is one that has the lowest AIC or BIC, and highest ratio of AIC/BIC change (Garson, 2010).

BIC values and the ratio of distance in group change are calculated in range from 1 to 15 clusters (Table 6.1). In general, the group with the lowest information criterion measure and the highest ratio of distance measures can be considered as a good number (Garson, 2010). Here, two group clustering generates the highest ratio of distance (2.3), but it has the second lowest BIC value

[24] Bayesian information criterion (BIC) is also called as Schwarz criterion. It is a criterion for model selection among a finite set of models. It is based on the likelihood function, and it is closely related to chi-squared fitting. The detailed explanation could be find in " Estimating the dimension of a model" (Schwarz, Gideon E, 1978)

(522.7). Three-group clustering generates the lowest BIC values (519), but it has a lower ratio of distance measure (1.8) as compared to two-group clustering. Since there is no theoretically correct optimum number of clusters, this approach suggests both two and three are a good number for clustering producers' *MLV*. The Mardia rule of thumb discussed above generates similar results as the information criterion approach.

Table 6.1: BIC for 1-15 Auto-Clusters base on MLV

Auto-Clustering				
Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change[a]	Ratio of BIC Changes[b]	Ratio of Distance Measures[c]
1	604.6			
2	522.7	-81.9	1.0	2.3
3	519.0	-3.6	0.0	1.8
4	543.4	24.4	-0.3	1.1
5	569.9	26.5	-0.3	1.5
6	607.3	37.4	-0.5	1.1
7	645.8	38.5	-0.5	1.5
8	691.0	45.3	-0.6	1.2
9	738.8	47.8	-0.6	1.1
10	787.8	49.0	-0.6	1.0
11	837.2	49.4	-0.6	1.2
12	887.7	50.6	-0.6	1.1
13	938.7	51.0	-0.6	1.0
14	989.8	51.1	-0.6	1.1
15	1041.5	51.7	-0.6	1.0

[a] The changes are from the previous number of clusters.
[b] The ratios of changes are relative to the change in the two cluster solution.
[c] The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

6.3 Producer Classification Based on Clustering Analysis

Given the number of response measures collected, there are many possible schemes for identifying and assigning producer clusters. However, I use three methods to classify producer responses: 1) only *MLV* (most likely values), 2) only *R* (uncertainty range) and 3) the joint consideration of *MLV*, *R* (uncertainty range) and *B* (relative response asymmetry) values. In the survey, the first question, Q1: "*Do you believe climate is changing?"* is a key question to understanding underlying producer opinions and can be used as a benchmark. Accordingly, the first and second classification schemes select the most highly related remaining questions based on their degree of association or correlation of their *MLV* (Method 1) or *R* (Method 2) with the benchmark question. In the third classification scheme—Method 3, all three producer response types: *MLV, R* (uncertainty range) and *B* (relative response asymmetry) are used in order to incorporate as much information as possible but the number of response combinations makes the cluster analysis unmanageable. In order to simplify the analysis, factor analysis is used to select the most important components. Each of the three classification schemes are explained more fully and the results presented in the following sections.

6.3.1 Method 1: Clustering Analysis Based on *MLV* Responses

In this clustering scheme, only the *MLV* response is considered. According to the best value estimate for Q1, the climate change related questions Q2, Q6, Q9, Q12, and Q13 are selected since these questions have a high correlation value to Q1.

According to the K-means cluster analysis, both two- and three-cluster groupings provide a similar fit based on BIC criterion (Table 6.2). However, the two-cluster grouping is preferred[25] because 1) the interpretation of two-cluster groups is easier, and; 2) it simplifies further analysis and discussion.

Using the two cluster grouping, there are 55 producers in Group 1 and 77 producers are in Group 2. Each question's *MLV* Centroid value for Group 1 is greater than 5 (mean value) and the centroid value for Group 2 is less than 5. Group 1 producers, on average, express higher concern about climate change (Q1), and are labeled as *more concerned producers* (*MCP*). Their opinions on climate change are more influenced by news media, friends and family members (Q9-13). Group 2 can be labelled as *less concerned producers* (*LCP*) and display less concern about climate change. They are less influenced by other information sources.

In comparing the group response to Q1 (climate change), the *MCP* group has a *MLV* centroid of 7.1 as compared to the *LCP* value of 4.5. There is somewhat less difference in their response to Q2 (past weather events): *MCP* has a value of 6.4 while *LCP* has a value of 4.3. This might indicate that although the *MCP* group is somewhat less concerned about past events affecting their opinion on climate change, they are still considerably different from the *LCP g*roup. Regarding to causes of climate change, the *MCP* has a value of 6.7, indicating that they believe

[25] Based on the three-cluster grouping, there are 41 producers in Group 1, 46 producers in Group 2, and 45 producers in Group 3. For Group 1, the *MLV* centroids of all responses are less than 5, and those for Group 2 are greater than 5. However, the *MLV* responses to Q1-2 and Q6 are very similar between Group 2 and Group 3, which causes difficulty in interpreting differences in the MLV responses of different groups. Since both two and three -cluster groupings provide a similar fit based on the BIC criterion, the simpler 2-clutstering grouping is preferred.

humans are an important factor affecting climate change. In contrast, the *LCP* group has a value of 3.8, which indicates that they believe humans have only some effect. In terms of being influenced by others, similar patterns exist. News media, friends and family have more influence on *MCP*, and less influence on *LCP*.

In order to examine how well the two-cluster grouping fits the data, an ANOVA test is conducted to examine whether the difference in group means (centroid) is significant (Table 6.3). *F* tests of equal group means are rejected for all questions at the 1% significance level.

Table 6.2: Comparison of Two and Three- Cluster *MLV* Centroids

Final Cluster Centroids of MLV*					
Survey Questions	Two Clusters		Three Clusters		
	1: MCP*** (55)**	2: LCP*** (77)**	1 (41)**	2 (46)**	3 (45)**
Q1. Do you think that global climate is changing?	7.1	4.5	3.7	7.3	5.7
Q2. Do past extreme weather events affect your opinion?	6.4	4.3	2.7	6.4	6.2
Q6. Do you believe that global climate change is mostly caused by human activities?	6.7	3.8	3.1	6.8	4.9
Q9. How much do ***"newspaper and magazines"*** influence your climate opinion?	5.5	2.8	2.1	5.4	2.6
Q12. How much do ***"friends"*** influence your climate opinion?	5.1	2.2	2.3	5.7	3.4
Q13. How much do ***"family members"*** influence your climate opinion?	5.6	2.4	2.3	5.9	2.8

*MLV is producer most likely value or their best guess
** Number in parentheses are the number of respondents in the cluster
*** MCP indicates *more concerned producer* and LCP indicates *less concerned producer*

Table 6. 3: ANOVA Table for *MLV* Cluster

ANOVA						
MLV*	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Q1	219.6	1	2.8	130	77.6	0.0
Q2	140.1	1	4.9	130	28.5	0.0
Q6	286.6	1	3.5	130	80.9	0.0
Q9	240.3	1	2.3	130	104.9	0.0
Q12	255.5	1	2.5	130	100.4	0.0
Q13	334.7	1	2.1	130	160.5	0.0

*MLV is most likely value

6.3.2 Method 2: Clustering Analysis Based on *R Responses*

The clustering analysis is similarly conducted based on producer uncertainty level of their MLV responses, *R*. The first question, Q1: "*Do you believe climate is changing?"* is again a key question to understanding underlying producer opinions and can be used as a benchmark. The second classification scheme also selects the most highly related questions to Q1. Not surprisingly, the *R* values of the remaining questions are highly correlated, unlike Method 1. This indicates that there is a similar level of uncertainty in answering all questions. In some cases, uncertainty may indicate scepticism or doubt and the scepticism is applicable to all questions. For example, if a producer is unconvinced and uncertain or "in doubt" about the response to one question, then he/she would also express doubt in responding to another question. Therefore based on the correlation value, Q1-2 and Q4-16 are selected for the second clustering scheme.

In Table A15 (see Appendix 2.7), the auto-clustering results are displayed for 1 to 15 clusters using the Bayesian Information Criterion (BIC) and the ratio of distance in group change. The two-cluster grouping generates the second lowest BIC values (855.2) and the highest Ratio of Distance (4.0). The three- cluster grouping generates the lowest BIC values (850.1), but the third highest ratio of distance measure (1.9). Since no cluster groupings have both the lowest BIC and the highest ratio of distance features, the two and three cluster groupings appear to be a good choice.

In order to visually review the reasonableness of the two and three- cluster groupings, the cluster centroids are displayed in Table 6.4. Based on the two- cluster groupings, there are 46 producers in Group 1 and 73 producers in Group 2. Group 1 is highly certain or confident in their responses, as indicated by the very low value of its centroid and Group 2 producers have somewhat higher centroid of *R* values (between 2.5 and 3.0), indicating greater uncertainty.

Similar to the findings presented for Method 1, both the two-clustering and three-clustering[26] results are reasonable. The two-cluster grouping is preferred for Method 2 for two reasons. One is that the third cluster of the three-cluster grouping is too small and does not add much information. Second, for the two cluster grouping, all the questions are highly significant as indicated by F value in the ANOVA table (Table A16, Appendix 2.7).

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[26] Based on the three cluster grouping, there are 32 producers in Group 1, 42 producers in Group 2, and 45 producers in Group 3. In Table 6.4, the Group 1 *R* centroids of each question shown are greater than 2, for Group 2 they are less than 1, and for Group 3, they are in between. Except for Q5 (number of years before change), Group 1 can be characterized as extremely uncertain and Group 2 is highly certain in all the remaining questions. Group 3 is somewhat more difficult to typify. They are very uncertain with respect to climate change (Q1) but at the same time they indicate somewhat less uncertainty as to the influence of the internet (Q11), friends (Q12) and family (Q14).

Using the two cluster grouping in Table 6.4, Group 1 producers are highly certain or confident in their responses as the centroids of their range are mostly well below 1. Hence, their *MLV* responses are such that they hold them to be "true" and hence, they are "confident" in their opinions and it will likely be more difficult to alter their opinions. Accordingly, Group 1 can be labeled as *confident producers* (*CP*) since they have very low *R* value (less than 1). This type of producer is less likely to be influenced by others than Group 2. In sharp contrast, the second group can be labelled as *unconfident producers* (*UCP*) since they have a much higher *R* scale with most *R* values ranging between 2.5 to 3.0. Accordingly, this producer group is not as confident in what they believe. While Group 2 producers may have a general tendency as indicated by their *MLV*, the "cloud" of their uncertainty means that their *MLV* value may be unreliable. It is possible that it may be easier to persuade these individuals to change their opinion on the topic of climate change.

Table 6.4: Comparing *R* Centroids between Two-group and Three-group Clustering

Final Cluster Centroids of R, Uncertainty *					
Survey Questions	Two Clusters		Three Clusters		
	1: CP*** (46)**	2: UCP*** (73)**	1 (32)**	2 (42)**	3 (45)**
Q1. Do you think that global climate is changing?	0.8	3.0	3.4	0.7	2.7
Q2. Do past extreme weather events affect your opinion?	0.7	2.9	3.3	0.6	2.5
Q4. What do you think the effect of climate change is on Canadian Prairie farm production?	0.6	3.0	3.7	0.5	2.4
Q5. How long do you think climate change will take before it begins to seriously affect your life?	0.6	1.8	2.1	0.5	1.6
Q6. Do you believe that global climate change is mostly caused by human activities?	0.6	2.9	3.5	0.5	2.3
Q7. How much do ***"climatologists or scientists"*** influence your climate opinion?	0.4	3.0	3.4	0.2	2.6
Q8. How much do "***environmental groups***" influence your climate opinion?	0.4	2.8	3.5	0.3	2.2
Q9. How much do ***"newspaper and magazines"*** influence your climate opinion?	0.3	2.7	3.3	0.2	2.1
Q10. How much do ***"radio and television"*** influence your climate opinion?	0.3	2.7	3.2	0.2	2.1
Q11. How much do ***"internet/world wide web"*** influence your climate opinion?	0.3	2.5	3.1	0.2	1.9
Q12. How much do ***"friends"*** influence your climate opinion?	0.3	2.6	3.2	0.2	2.0
Q13. How much do ***"family members"*** influence your climate opinion?	0.2	2.7	3.3	0.2	2.0
Q15.What do you think the experts are saying about climate change?	0.6	3.1	3.8	0.5	2.5
Q16.What do you think the experts are saying about the effect of climate change?	0.8	3.2	3.9	0.7	2.6

* R is range in uncertainty

** Number in parentheses are the number of respondents in the cluster

6.3.3 Comparing the Results of Method 1 and Method 3

The third method, grouping producers based on both *MLV* and *R* values using factor analysis is also used to analyze heterogeneity in producer responses. Factors are first extracted from both MLV and R values of a range of questions using factor analysis, and then clustering analysis is conducted based on the extracted factors. The clustering result of this method is very similar to the result derived from Method 1. Ultimately, Method 1 is chosen here based on simplicity and parsimony [27], whereas Method 3 is discarded. [28]

6.4 Crosstab Group Memberships Derived by Methods 1 and 2

Two clustering schemes are used to classify producers. This section evaluates Method 1 (*MLV)* and Method 2 (*R*) clustering methods using the final cluster membership. In addition, the cluster classifications are compared based on their similarity in identifying producer concern and confidence.

Membership in the *less concerned producers (LCP)* and *more concerned producers (MCP)* clusters identified by Method 1 are compared to the *confident producers (CP)* and *unconfident*

[27] First of all, according to what Yeung and Ruzzo (2001) conclude from their experimental research, clustering based on principle component analysis (Method 3) instead of the original variables (Method 1) does not necessarily improve and often degrades cluster quality. In addition, Method 1 is based on untransformed data; it is much easier to calculate and to interpret the underlying groups than Method 3. Moreover, the clustered variable extracted from factor analysis in Method 3 only explains 73% of the original variance (Table 16 in Appendix 2.8) and hence, if this method is used, 27% of the information will be lost. Therefore, Method 3 is excluded from further discussion.

[28] However for completeness, Method 3 is discussed in Appendix 4.

producers (UCP) clusters identified by Method 2. Comparisons are based on a simple cross-tabulation[29] of common members in order to show areas of commonality.

Method 1 producers are identified as less or more concerned. A total of 3 individuals could not be assigned to a group in Method 1 and a total of 16 individuals could not be assigned in Method 2. These are indicated by N/A and total 14% of the whole group. Using the most likely value (*MLV*) of producer responses, a total of 77 producers are identified as *less concerned producers (LCP)* and 55 producers are identified as *more concerned producers (MCP).* In the second typology set based on the producer uncertainty range, *R*, 73 producers are identified as *unconfident producers (UCP)* and 46 producers are identified as *confident producers (CP)*. The relationships between the four membership categories are shown in Table 6.5.

Table 6.5: Crosstab of Group Memberships Derived by Method 1 and Method 2

Comparison of Common Members										
Cluster Type		Uncertainty Clusters)						Grand Total	
		Confident Producers**		*Unconfident Producers***		Unclassified			
MLV Clusters	MCP*	28	21%	39	29%	10	7%	77	57%
	LCP*	18	13%	32	24%	5	4%	55	41%
	Unclassified	0	0%	2	1%	1	1%	3	2%
Grand Total		46	34%	73	54%	16	12%	135	100%

*MCP indicates *more concerned producer*, and LCP indicates *less concerned producer*
** CP indicates *confident producer*, and UCP indicates *unconfident producer*

[29] Cross tab table is commonly known as pivot table that is heavily used in survey research. It is the process of creating a contingency table from the multivariate frequency distribution of statistical variables. In order to summarize or compare the data from one or more of fields in a compact format, this paper used many cross tabulation forms. Table 5.1, Table 6.5, and Table 6.7 are the examples of cross tab table.

Excluding unspecified (N/A) producers, 36% (28/77) of *more concerned producers (MCP)* are classified as being *confident (CP)* and 51% (39/77) of *MCP* producers are classified as being *unconfident (UCP)*. In the *less concerned producers* (*LCP*) category, 33% (18/55) of producers are classified as *confident* (*CP*) and 58% (32/55) are classified as *unconfident* (*UCP*). Based on this table, there is little evidence to show that Method 1 and Method 2 generate similar group membership. In other words, some *more concerned producers (MCP)* display confidence but more do not. Likewise, some *less concerned producers* (*LCP*) display confidence but more do not. Therefore these two classifications represent two different dimensions of producer opinion.

A total of 21% of all producers are classified as both *MCP* and *CP*. This group is concerned about climate change and highly confident in their opinion. There are 13% of all producers which are *LCP/CP* —less concerned and highly confident in their opinions. These two groups are unlikely to change their minds about climate change. Table 6.8 demonstrates that the influential factors for group *CP* are ranked as: 1) Past extreme events; 2) Climatologist; 3) Internet; 4) Radio and TV; and 5) newspapers and magazines. This indicates that confident producers are more influenced by past extreme events and climate experts. In general, friends have the least influence on *confident producers.* This interesting finding may help policy makers or organizations to develop mechanisms to better influence producer opinion on climate change.

Of greater interest from a policy perspective is the group that consists of producers who are not confident in their opinions (*UCP*), because these producers are more likely to be influenced and change their opinions than the *confident producer* group. About 29% of total producers are more concerned but with greater uncertainty in their opinions *(MCP/UCP).* Those who are *less* *concerned producers (LCP)* but are not confident *(LCP/UCP)* account for 24% of all producers. These groups are influenced by a variety of sources, in order: 1) Past extreme events; 2) Climatologist; 3) Radio and TV; 4) Family members; and 5) Internet (Table 6.6).

Table 6.6: Comparison of Most-Likely Values of Perceived Importance of Information Sources of Different Producer Groups

Information Sources	*Confident Producers*			*Unconfident Producers*		
	All	Less Concerned	More Concerned	All	Less Concerned	More Concerned
Past Extreme Events	5.12	4.99	5.35	5.33	5.2	5.3
Climatologists and Scientists	4.9	5.12	4.79	4.65	4.55	4.84
Environmental Groups	3.48	3.03	4.27	3.45	2.85	4.63
Newspaper and Magazines	3.87	3.72	4.21	3.69	3.27	4.5
Radio and TV	3.91	3.67	4.39	4.04	3.7	4.71
Internet	3.96	3.97	4.77	3.86	3.41	4.68
Friends	3.4	3.22	3.64	3.29	3.35	3.26
Family Members	3.48	3.31	3.77	3.93	3.82	4.23

6.5 Profiling Producers by Cluster

It was posited that producer opinion is associated with demographic variables such as gender, age, tenure, farm type, and farm size. The demographic characteristics of gender, age, tenure, farming type, and farm size are reported for the Method 1 (MLV: *LCP*/*MCP)* producer groups are presented in Table A23 in Appendix 2.11 and Method 2 (R Response: *UCP*/*CP*) producer groups in Table A24 in Appendix 2.12. The MLV (Method 1) and R response (Method 2) classification outcomes are profiled by producer, gender, farm size, and farm type using a binary logistic regression model.

In the case of Model 1, the dependent variable is group membership, which takes a value of 1 for those who are in the *less concerned producer* group and 0 for those who are in the *more concerned producer*. Note that age has been excluded since it is the least correlated to dependent variable. A total of 108 (80% of all participants) producers responses are included in a regression model, and 27 (20%) are excluded as these data are missing (Table 6.7).

Table 6.7: Case Summary for Model 1 Logit Regression *(MCP/LCP)*

Case Processing Summary			
Unweighted Cases		N	Percent
Selected Cases	Included in Analysis	108	80%
	Missing Cases	27	20%
	Total	135	100%
Unselected Cases		0	0%
Total		135	100%

The estimated Method 1 (MLV) model maximum likelihood parameters and summary statistics are displayed in Table 6.8. These estimates indicate the amount of increase or decrease in the predicted log odds ratio between LCP *and MCP* that can be predicted by a 1 unit increase in the predictor, while holding all other predictors constant. For instance, for every one unit increase in farm size, there is a 0.36 increase in the log-odds of being a *less concerned producer*. However, most estimated coefficients are not statistically significant, based on the Wald test, except farm type (p=.03) and possibly, size (p=.10). This translates to a very low predictive level: only a total of 65.7% of MLV classes are predicted correctly (Table 6.9).

Table 6.8: Method 1 and Demographics Regression Results

Variables in the Equation				
	Coef.	S.E.	df	Sig.
Gender	-0.40	0.52	1	0.45
Tenure	0.19	0.23	1	0.40
Type	-0.50	0.22	1	0.03
Size	0.36	0.22	1	0.10
Constant	-0.23	0.85	1	0.79

Table 6.9: Percentage of Prediction for *MLV*

Classification Table				
Observed		Predicted		
		Method 1 (MLV)		Percentage Correct
		0*	1*	
Method 1 (MLV)	0*	20	25	44.4
	1*	12	51	81.0
Overall Percentage				65.7

* 0 indicates *more concerned producer (MCP)*, and 1 indicates *less concerned producer (LCP).*

As in the previous section, a binary logistic regression model is similarly chosen to explain Method 2 group membership with socio-demographic information. A cross tabulation of the demographic characteristics and Method 2, *unconfident producer* (*UCP*) and *confident producer* (*CP*) classification is displayed in Appendix 2.12, Table 24. As in Method 1, the demographics of the different groups are similar and there appears to be no discernible relationship between demographic variables and producer opinions. The relationship is tested using a binary logistic regression model. The dependent variable is group membership, which takes a value of 1 for *Unconfident producers and 0 for Confident producers.* The same explanatory variables of producer age, gender, tenure, farm type and farm size are used as in Model 1. A total of 96 (71%) data are included and 36 missing data are deleted from the model (Appendix Table A28).

Table 6.10: Case Summary for Regression *(UCP/CP)*

Case Processing Summary			
Unweighted Cases		N	Percent
Selected Cases	Included in Analysis	96	71%
	Missing Cases	39	29%
	Total	135	100%
Unselected Cases		0	0%
Total		135	100%

The estimated parameters and their associated statistical significance based on the Wald test are displayed in Table 6.11. Based on the Wald test, none of the coefficients are significant, meaning that there is no statistical evidence to support a relationship between producer demographics and opinion confidence levels and the prediction level is only slightly higher than a coin flip-- only 59% of producers could be predicted correctly (Table 6.11).

Table 6.11: Method 2 and Demographics Regression Results

Variables in the Equation				
Variable	Coef.	S.E.	df	Sig.
Age	-0.02	0.15	1	0.90
Gender	-0.25	0.60	1	0.68
Tenure	-0.04	0.24	1	0.86
Type	0.06	0.22	1	0.79
Size	-0.11	0.23	1	0.63
Constant	0.02	0.90	1	0.98

Table 6.12: Percentage of Prediction for *R*

Classification Table				
Observed		Predicted		
		Method 2 (R)		Percentage Correct
		0*	1*	
Method 2 (R)	0*	57	0	100.0
	1*	39	0	.0
Overall Percentage				59.4

* 0 indicates *confident producer (CP),* and 1 indicates *unconfident producer (UCP).*

6.6 Summary and Conclusions

In brief summary, two alternative classification schemes based on actual *MLV* and *R* responses are selected. These represent two different dimensions of producer opinions: 1) *more concerned producers (MCP) / less concerned producers* (*LCP*) and 2) *confident* (*CP*) / *unconfident* (*UCP*). There is very little evidence that these cluster groupings are affected by their demographic characteristics; it seems that differences are due to intrinsic differences among the individual respondents.

CHAPTER SEVEN: SUMMARY AND CONCLUSION

7.1 Introduction

This research analyzed Canadian prairie agricultural producer attitudes towards climate change based on opinion surveys conducted in 2008. The following areas are assessed: the degree of individual producer uncertainty; the influence of producer interaction with others and information from the media in establishing their opinion; the role of expert groups in influencing producer opinions; and the influence of producer memory of past climatic events. The purpose of this chapter is to provide an overview of the major findings from the analysis and results sections of this thesis. First, a summary of the research findings from the theoretical framework, the producer survey and the key results of the analysis are provided. Secondly, a discussion of implications from the empirical work is provided. Finally, the primary study limitations are discussed, along with recommendations for future research.

7.2 Summary and Review of Findings

One of the problems associated with climate change is that not all experts or producers accept the existence of change, the cause, or the degree of change. Some of the disputed issues include the following: whether the global warming trend is within normal climatic variation, whether humankind has contributed to the change significantly, whether temperature increases are a reliable measurement, and what the consequences of global warming will be. Accordingly, a survey instrument is developed based on opinion dynamic model. Opinion conviction is measured using a “Visual Analogue Scale (VAS)”. Four VAS values are recorded: most-likely-value (MLV), lower (L) and upper (U) bound values and range of participant uncertainty (R). In order to identify groups of individuals with similar opinions, cluster analysis techniques are introduced. In addition, attempts are made to profile clusters with socio-demographic characteristics using logistic regression models.

Of the 135 producers surveyed, 65% think that there will be considerable climate change but 34% of producers believe there will be moderate change or less. Considering the extreme climate /weather events of the past 10 years, 7% of sample producers have not changed their climate change opinion; 84% of producers have changed their opinion somewhat and 7% have changed their opinion considerably. There are 36% of surveyed producers who think that climate change would be a net cost to the Canadian Prairies, while 39% of producers think it would create a net benefit. Most producers (66%) think that climate changes will affect the Canadian Prairies relatively soon (5-25 years). Only 48% of producers believe that human activity has had considerable impact on climate change. The two most important influences on producers are the categories of "Climatologist" and "Radio and TV". Finally, producer beliefs cannot be explained by demographic variables and thus appear to be intrinsic to the individual.

A total of 23 experts completed the survey and they seem to hold stronger beliefs than producers that climate will change considerably. They believe that the Canadian Prairies would face a net cost from climate change and that human activities contribute significantly to this change. While experts think that public and producers are much less concerned about the impact of climate change, producers also think experts and media have over-stated the case for climate change. But experts also allow for greater uncertainty than producers. They rely on "Radio and TV" to obtain information on climate change but rely less on information provided by the category "environmental group".

Finally, cluster analysis is used to group the producers into clusters based on their similarity in opinion. Logistic regression analysis is subsequently used to help identify the relationship between cluster membership and producer characteristics. Two classification schemes, referred to here as Method 1 (MLV) and 2 (R - relative uncertainty), representing two different dimensions of producer opinion are used to classify group membership.

Two clusters are identified using Method 1: *more concerned producers (MCP)* and *less concerned producers (LCP)*. The clusters are somewhat different in size: 41% of producers are *MCP*, and 57% producers are *LCP*. Compared to *LCP*, the *MCP* group is more concerned about climate change, since: 1) they think that climate change is more probable (7.1 to 4.5, Table 6.2); 2) they have been more influenced by past extreme weather events (6.4 to 4.3); 3) they believe human activity is largely responsible for climate change (6.7 to 3.8); 4); and they are more easily influenced by "newspapers and magazines", "friends", and "family members" (5.1 to 2.2). Based on the regression findings, there is little statistical evidence that producer opinions are associated with demographic characteristics.

Method 2 identified two clusters: *unconfident producers (UCP)* and *confident producers (CP).* The group members are identified based on their relative belief uncertainty (*R* value). The *R* values of the remaining questions are similar, and indicating that there is a similar level of uncertainty in answering all questions (i.e. those in doubt in one question would express doubt in another question). A total of 35% of producers are confident in their responses but 55% of producers are not very confident in what they believe; the remaining 10% are outliers and unclassified. Based on logistic regression analysis, there is again little evidence that producer opinion uncertainty is associated with demographic characteristics. Opinion characteristics seem to be intrinsic to the individuals themselves.

Using Methods 1 and 2 as the two axes of group description, groups of potential policy interest are the producers who are concerned about climate change and highly confident that they are correct *(MCP/CP*). They account for a total of 21% of all producers. There are 13% of producers who are less concerned about climate change and highly confident in their opinions *(LCP/CP).* These two groups of producers are unlikely to change their minds because they are more confident in their opinion than the other two groups of producers.

Of particular policy interest is the unconfident group of producers, as it is possible that this group may be more easily influenced or convinced to change their opinion. This group *(UCP)* accounts for 54% of all sample producers. Within this category, the *more concerned producers (MCP / UCP)* represent 29% of total producers, while the *less concerned producers (LCP)* producers *(LPC /UCP)* represent 24% of all producers. Both groups may be influenced through a variety of communication channels/categories including climatologist, Radio and TV, and family members.

7.3 Policy Implications

According to the producer survey, all producers believe human activity has some impact on climate change but only 22% strongly believe it to be mostly caused by human activity (response value = 8 to 10). This hints at the potential difficulty in convincing producers to voluntarily take action to mitigate climate change. In addition, a discord between agricultural interests and climate change needs to be bridged if mitigation and adaptation policies are to be embraced by the Prairie agricultural community. For instance, comparing producers and experts' opinion on the same climate change question, experts believe, in general, that there is a greater degree of climate change than producers; but they also have a greater degree of uncertainty than producers. This may reflect differing views on climate change among experts and in academia. The widely different views on climate change held among experts in governments, academia and in media and among different social groups increases the challenge in developing and implementing effective mitigating policies to adapt to any actual climate change.

Based on producer opinion on climate change and the uncertainty level on their opinion, four sub groups are classified in this study. This implies that one climate change policy might not be able to fit all the producers' needs. It is important for government to identify those producers with different opinions and different levels of uncertainty about their opinion. Unfortunately, this study did not find any evidence to show that producer climate change opinion is related to their demographic characteristics. This increases the difficulty of identifying producers. However influencers of opinion are more readily identifiable: this study finds that climatologists/scientists have the highest influence over producers, while radio/television and newspapers/magazines are the second and third most important. This indicates that even though government could not easily identify producers, they could encourage climatologists/scientists to directly influence producers more and use radio/TV and newspapers/magazines to directly educate producers on the climate change issue, in order to strengthen their response to policy.

7.4 Study Limitations

One limitation of this study is that it only studies producer opinions towards climate change and does not include the producer willingness to mitigate or adapt to climate change. In addition, some important demographic information such as producer income and education level is not collected in the survey. These factors may be important in contributing to producer climate change opinion. In general, the Visual Analogue Scale was a reliable instrument for valid measurement but it requires manual measurement. In the case of internet-based research (online generator), the response can be easily captured and very precisely measured possibly even in millimeters. Manual measurement increases the difficulty of data recording and interpretation, affecting data accuracy, and can be a burden for the researcher. In contrast, direct elicitation of response strength of conviction would result in more exact values and require less explanation from the participants.

The results are also limited by the relatively small number of observations, reducing confidence in any conclusions that might be drawn from the analysis. Even though the sample was broadly representative of the farm population based on comparisons to the Census of Agriculture, care should be used in using a sample of 150 responses to draw implications about all Canadian prairie producers. Lastly, because the data were collected in June of 2008, accuracy of the data might be lower than it would be if the survey had been done in late 2010. For example, extreme weather events such as the 2010 Saskatchewan and Australian floods may have significantly changed individual opinion towards climate change.

7.5 Area for Further Research

There are several opportunities for future research on producer opinions and their reactions to climate change. In addition, in order to study and examine farm - level adaptation to risks and opportunities presented by climate change, the producer willingness to respond to climate change should be updated in the survey. Producer risk perception of climate change is another important aspect to be studied. This is particularly important in the area of climate change and the appropriate technical response. Public risk perceptions are critical components of the social politic context within which policy makers operate; they can fundamentally compel or constrain political, economic and social action to address particular risk (Anthony 2006). Another important area is producer support for voluntary and government actions, and producers' general environmental beliefs. Of particular interest to researchers are the relationships between demographic variables such as education and annual income, and producer opinions. Psychological, socio-cultural, and experiential factors, such as effect, imagery and values may influence producers' risk perceptions and support for public programs and should accordingly be studied.

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APPENDIX 1: SURVEY

Appendix 1.1: Letter of Invitation

UNIVERSITY OF SASKATCHEWAN

Department of Bioresource Policy, Business and Economics
51 Campus Drive, Saskatoon, SK
S7N 5A8 Canada
Telephone: (306) 966-4008
Fax: (306) 966-8413

July 2008

Dear Participants,

You are invited to participate in a study entitled "Prairie Farmer Decision Making in Time of Climate Change and Increased Economic and Environmental Volatility". Please read this letter carefully and feel free to ask any questions that you might have.

The purpose of the research is to survey producers as to their opinions as to the impact of potential climate change on Canadian prairies. Your responses will help us to better understand producer opinions and how they are formed. It is expected that the survey should last between 5 - 8 minutes.

This research is funded by CCIAP (Climate Change Impacts & Adaptation Program) of Natural recourses Canada department. The research conclusions will be published in a variety of formats, both print and electronic. These materials may be further used for purposes of conference presentations, or publication in academic journals, books or popular press.

Participation in this survey poses no personal risk. Data and information provided by surveys will be reported in an aggregate form that protects the confidentiality and the anonymity of individual participants. In principle, actual names will not be used. The survey data will be securely stored by the Research Advisor, Dr. Richard Schoney, at the Department of Bioresource Policy, Business and Economics for a period of ten years. This information will only be available to the researchers for the purpose of this study. Your participation is completely voluntary and you may withdraw from the study for any reason, at any time, without penalty. You may also refuse to answer individual questions. Return of the survey questionnaire to the Researcher's indicates your consent to participate in this study.

If you have any questions concerning the study, please feel free to ask at any point by contacting the Researchers at the numbers provided below. The University of Saskatchewan Behavioural Research Ethics Board on ________ has approved this study on ethical grounds. Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (306-966-2084). Out of town participants may call collect.

Researcher

Ms. Wei He
Dept. of Bio-resource Policy, Business and Economics
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(306) 966-4043

Dr. Richard Schoney, Professor
Dept. of Bio-resource Policy, Business and Economics
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Department of Bioresource Policy, Business and Economics
UNIVERSITY OF SASKATCHEWAN

51 Campus Dr. Saskatoon, S7N 5A8
University of Saskatchewan

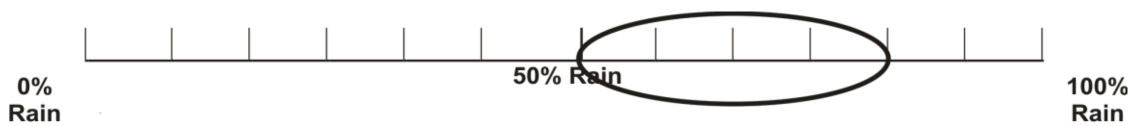
Global Climate Change Opinion Survey

There are many opinions today about the extent of global climate change. In the following survey, we are not concerned about the cause of climate change but only seek **your opinion** on the magnitude of climate change (if any) and its impact on Saskatchewan agriculture.

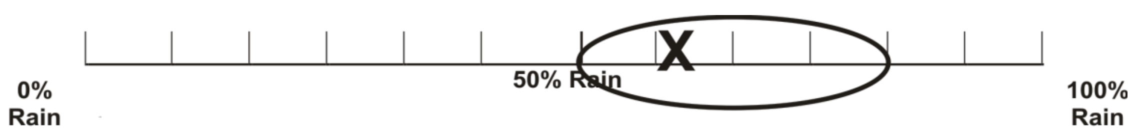
To fill out this survey, we would like you:

1. To draw a **range** of values that you feel almost certain (say, 95%) contains what you believe is the right or true answer.
2. and then indicate your **"best guess"** (the most likely value) with an **"X"** inside the range that you draw (it is not necessary to have it be in the middle)

For Example:
In trying to guess the weather, consider the chance of rain tomorrow. As you can see on the line shown below, at the far left lies the point where you are certain that it will not rain (0% chance). And at the far right, you are certain it will rain (100% chance). If you think that **there is some chance it might rain, say 50% to 70%, then you would draw a circle like the following:**



and then, if **your "best guess" is more towards the left of your circle (near to a 50% chance),** you would place an "**X**" as shown. This type of response shows that you are leaning towards less chance of rain overall. Of course, your "X" could be placed in the middle if you believe that the chance of rain lies exactly in the middle.



Once Completed:

- If you are satisfied with your responses, please hand in the completed questionnaire. Return of the prize draw entry form is optional.
- If you have any questions, comments or concerns, please contact the researchers.
- Your responses are strictly confidential and will be used for statistical purposes only**.**

Appendix 1.2: Producer Survey

Part I: Your views on climate change:

1. Do you think that global climate is **changing?**

No Change													Considerable Change

"No Change"	**"Considerable Change"**
You believe that current climate change is not unusual, but a normal weather variation (for example, current weather patterns are simply part of a cycle that has occurred throughout earth's history)	You believe that one or more of the following effects are permanent: 1. Warmer and fewer cold days and nights, warmer and more frequent hot days and nights; 2. More frequent heat waves, heavy precipitation events, droughts over larger areas 3. More intense tropical cyclone, hurricanes and tornadoes 4. Higher sea levels

2. If you were to actually *experience* one or more years of an extreme weather event (e.g. the prolonged drought in Australia; the extremely hot summer in Europe in 2003; the intense North Atlantic hurricane seasons of 2004 and 2005 or the extreme rainfall events in Mumbai, India in July 2005), do you think this would affect your opinion on the issue?

No Opinion change						Slight change	Opinion						Considerable Opinion Change

3. How much have you changed your "climate" opinion in the past 10 years? Please check the appropriate box as follow.

☐ no change ☐ small change ☐ moderate change ☐ large change

4. For the moment, assume <u>there will be some permanent climate change on earth.</u> Given this, what do you think will be the overall effect of climate change on Canadian prairie farm production?

Net Cost													Net Benefit

“Potential Climate Change Costs”	“Potential Climate Change Benefits”
1. Extreme weather events: drought/ flooding/heat waves/storms; 2. Decreasing water availability; 3. Increasing amphibian extinction/ species range shifts and wildfire risk	Warmer temperatures result in longer growing seasons and warmer weather which allows new crops and new markets.

5. Again assume <u>there will be some level of permanent climate change.</u> How long do you think it will take before climate change begins to seriously affect your personal or business life, requiring you to make changes and adapt?

immediately | 10 years | 20 years | 30 years | 40 years | 50 years | 60 years or more

6. Finally, do you believe that global climate or "average weather" change is mostly caused by human activities?

No Effect | Considerable Effect

Part II: Please tell us your views on “expert” (climatologist, scientists) opinions:

7. Tell us what you think the experts are currently saying about climate change.

No Change | Some Change | Considerable Change

8. Tell us what you think the experts are saying about the net benefits/costs of climate change to the Canadian prairies:

Net Cost | 0 | Net Benefit

9. Tell us what you think the experts are saying about <u>how long</u> it will take before climate change will begin to seriously affect the Canadian prairies:

immediately | 10 years | 20 years | 30 years | 40 years | 50 years | 60 years or more

10. Indicate the influence of the following **“experts”** on **<u>your own</u> opinions** about climate change. <u>Considerable influence</u> indicates that you would take the expert’s opinion <u>as your own</u>.

A. Climatologists or scientists

No Influence Some influence Considerable Influence

B. Environmental groups

No Influence Some influence Considerable Influence

C. Newspaper and magazines

No Influence Some influence Considerable Influence

D. Radio and Television

No Influence Some influence Considerable Influence

E. Internet / World Wide Web

No Influence Some influence Considerable Influence

F. Friends

No Influence Some influence Considerable Influence

G. Family Member

No Influence Some influence Considerable Influence

H. Others ________ (specify)

No Influence Some influence Considerable Influence

11. Please check the following boxes that best represent your personal information.

Age	Gender	Land Farmed 10years	Farm Type (base on % of income)	Farm Size	Farm Location (RM / Soil Zone)
☐ <30 ☐ 30 - 40 ☐ 40 - 50 ☐ 50 - 60 ☐ >60	☐ male ☐ female	☐ ___ % owned ___ % leased	☐ grain ☐ livestock ☐ mixed: _____ % grain ______% livestock ☐ other (_________)	☐ < 160acres ☐ 160 - 640 ☐ 640 - 1280 ☐1280-5120 ☐ > 5120	

Thank you for taking the time to complete this survey. If you have any additional comments please feel free to provide them on the rest of this page.

Appendix 1.3: Expert Survey

Part I: Your views on climate change:

1. Do you think that global climate is **changing?**

No Change		Considerable Change

"No Change"	**"Considerable Change"**
You believe that current climate change is not unusual, but a normal weather variation (for example, current weather patterns are simply part of a cycle that has occurred throughout earth's history)	You believe that one or more of the following effects are permanent (check those effect that you think are important): ☐ 1. Warmer and fewer cold days and nights, warmer and more frequent hot days and nights; ☐ 2. More frequent heat waves, heavy precipitation events, droughts over larger areas ☐ 3. More intense tropical cyclone, hurricanes and tornadoes ☐ **4.** Higher sea levels

2. If you were to actually *experience* one or more years of an extreme weather event (e.g. the prolonged drought in Australia; the extremely hot summer in Europe in 2003; the intense North Atlantic hurricane seasons of 2004 and 2005 or the extreme rainfall events in Mumbai, India in July 2005), do you think this would affect your opinion on the issue?

No Opinion change	Slight Opinion change	Considerable Opinion Change

3. How much have you changed your "climate" opinion in the past 10 years? Please check the appropriate box below:

☐ no change	☐ small change	☐ moderate change	☐ large change

4. For the moment, assume <u>there will be some level of permanent climate change on earth.</u> Given this, how long do you think it will take before climate change begins to seriously affect your personal or business life, requiring you to make changes and adapt?

immediately	10 years	20 years	30 years	40 years	50 years	60 years or more

5. Again assume <u>there will be some permanent climate change.</u> What do you think will be the overall effect of climate change on Canadian prairie farm production?

Net Cost Net Benefit

“Potential Climate Change Costs”	“Potential Climate Change Benefits”
1. Extreme weather events: drought/ flooding/heat waves/storms; 2. Decreasing water availability; 3. Increasing amphibian extinction/ species range shifts and wildfire risk	Warmer temperatures result in longer growing seasons and warmer weather which allows new crops and new markets.

6. Finally, do you believe that global climate or “average weather” changes are mostly caused by human activities?

No Effect Considerable Effect

Part II: Please tell us your views on “public” and producer opinions on climate change:

7. Is the general public in Canada concerned about climate change?

No Concern Some Concern Highly Concerned

8. How are the media currently portraying the issue of climate change?

Poor job Reasonable Job Good Job

9. Do you think Canadian farmers are concerned about climate change?

No Concern Some Concern Considerable Concern

10. How do farmers perceive the net benefits or costs of climate change on the Canadian Prairies?

Net Cost 0 Net Benefit

11. How long do you think farmers will say that it would take before climate change begins to seriously affect the Canadian Prairies?

immediately 10 years 20 years 30 years 40 years 50 years 60 years or more

12. Please indicate what influence you believe the following groups or individuals have on farmers in Canada concerning climate change.

A. Climatologists or scientists

No Influence Some influence Considerable Influence

B. Environmental groups

No Influence Some influence Considerable Influence

C. Newspaper and magazines

No Influence Some influence Considerable Influence

D. Radio and Television

No Influence Some influence Considerable Influence

E. Internet / World Wide Web

No Influence Some influence Considerable Influence

F. Friends

No Influence Some influence Considerable Influence

G. Family Member

No Influence Some influence Considerable Influence

13. Please check the following boxes that best represent your personal information.

Country	**Education Level**	**Specialty**
	☐ M.Sc. ☐ PHD. ☐ Post PHD. ☐ other (__________)	☐ Climatologist ☐ Economist ☐ Ecologist ☐ other (_________)

Thank you for taking the time to complete this survey. If you have any additional comments please feel free to provide them on the rest of this page.

APPENDIX 2: SURVEY RELATED TABLES AND FIGURES

Appendix 2.1: Question Sequence Collation Table

Appendix Table A1: Collation of Survey Question No.

Producer Survey		Export Survey	
Question No. in Survey	Question No. in Data File	Question No. in Survey	Question No. in Data File
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	5
5	5	5	4
6	6	6	6
7	15	7	18
8	16	8	19
9	17	9	20
10-A	7	10	21
10-B	8	11	22
10-C	9	12-A	7
10-D	10	12-B	8
10-E	11	12-C	9
10-F	12	12-D	10
10-G	13	12-E	11
10-H	14	12-F	12
		12-G	13

Appendix 2.2 Grouped Producer Identification

Appendix Table A2: Grouped Producers Identification - 1

Producer ID	Group Membership -- Method				Survey Location	Particpant Location	Age	Gender	Land Farmed	Farm Type	Farm Size (ACRES)	Soil Zone
	1: B	2: MLV	3: R	4: MLV& R								
1	SB	MCP	UCP	NCP	WFPS	SK	> 60	M	owned	Grain	640 -1280	Brown
2	CB	MCP	CP	NCP	WFPS	U	40 - 50	F	owned	Livestock	1280 - 5120	U
3	AB	MCP	CP	NCP	WFPS	U	<30	M	U	Mixed	<160 acres	U
4	SB	MCP	CP	NCP	WFPS	U	50 - 60	M	mixed	Mixed	640 -1280	U
5	AB	MCP	UCP	NCP	WFPS	U	30 - 40	F	owned	Grain	1280 - 5120	U
6	CB	LCP	CP	NBP	WFPS	U	40 - 50	M	mixed	Grain	1280 - 5120	U
7	SB	LCP	CP	NCP	WFPS	U	50 - 60	M	mixed	Grain	>5120	U
8	AB	MCP	UCP	NCP	WFPS	U	50 - 60	M	mixed	Grain	1280 - 5120	U
9	SB	MCP	UCP	NCP	WFPS	U	30 - 40	F	owned	Other	<160 acres	U
10	SB	LCP	UCP	NBP	WFPS	U	<30	M	owned	Mixed	1280 - 5120	U
11	CB	MCP	UCP	NCP	WFPS	SK	<30	M	mixed	Mixed	640 -1280	U
12	SB	MCP	CP	NCP	WFPS	U	<30	M	U	Livestock	640 -1280	Dark Brown
13	SB	LCP	UCP	NBP	WFPS	U	> 60	M	mixed	Mixed	1280 - 5120	Black
14	SB	MCP	N/A	NCP	WFPS	U	40 - 50	F	mixed	Mixed	1280 - 5120	U
15	CB	LCP	UCP	N/A	WFPS	U	> 60	M	owned	Grain	640 -1280	U
16	CB	LCP	CP	NCP	WFPS	U	<30	F	U	U	U	U
17	SB	LCP	N/A	NCP	WFPS	U	<30	F	mixed	Mixed	160 -640	Black
18	AB	N/A	UCP	NCP	WFPS	U	<30	F	mixed	Mixed	640 -1280	U
19	CB	LCP	CP	NBP	WFPS	U	> 60	M	owned	Grain	1280 - 5120	Gray
20	SB	MCP	CP	NCP	WFPS	U	50 - 60	F	owned	Grain	1280 - 5120	Black

Appendix Table A3: Grouped Producers Identification - 2

Producer ID	GroUCP Membership -- Method				Survey Location	Particpant Location	Age	Gender	Land Farmed	Farm Type	Farm Size (ACRES)	Soil Zone
	1: B	2: MLV	3: R	4: MLV& R								
21	SB	MCP	UCP	NCP	WFPS	U	> 60	M	owned	Mixed	1280 - 5120	Black
22	SB	LCP	CP	NBP	WFPS	U	50 - 60	M	mixed	Mixed	1280 - 5120	U
23	SB	LCP	CP	NBP	WFPS	U	> 60	M	owned	Livestock	>5120	U
24	SB	LCP	UCP	NBP	WFPS	U	40 - 50	M	mixed	Livestock	1280 - 5120	U
25	CB	MCP	CP	NCP	WFPS	U	40 - 50	M	mixed	Livestock	1280 - 5120	U
26	SB	LCP	CP	NCP	WFPS	U	50 - 60	M	mixed	Mixed	640 -1280	Dark Brown
27	SB	MCP	N/A	NCP	FFP	U	dno't know	U	U	U	U	U
28	CB	LCP	CP	NBP	WFPS	U	30 - 40	M	U	Mixed	640 -1280	U
29	AB	LCP	CP	NBP	FFP	AB	40 - 50	M	mixed	Grain	1280 - 5120	U
30	AB	LCP	CP	NBP	WFPS	MB	40 - 50	M	owned	Mixed	>5120	Black
31	AB	MCP	N/A	NBP	WFPS	SK	30 - 40	M	mixed	Mixed	1280 - 5120	U
32	AB	LCP	CP	NBP	WFPS	INT	<30	M	U	U	U	U
33	SB	LCP	UCP	NBP	WFPS	U	40 - 50	M	owned	Livestock	640 -1280	U
34	SB	LCP	CP	NBP	WFPS	U	40 - 50	M	mixed	Grain	1280 - 5120	U
35	SB	LCP	UCP	NBP	WFPS	U	40 - 50	M	mixed	Mixed	1280 - 5120	U
36	CB	LCP	UCP	NBP	WFPS	U	<30	M	owned	Grain	640 -1280	U
37	CB	LCP	CP	NBP	WFPS	U	50 - 60	M	owned	Mixed	>5120	U
38	AB	MCP	CP	NCP	WFPS	U	<30	M	owned	Livestock	640 -1280	U
39	SB	MCP	CP	NCP	WFPS	SK	40 - 50	M	owned	Grain	1280 - 5120	U
40	SB	LCP	N/A	NBP	WFPS	SK	> 60	M	owned	Mixed	>5120	U
41	AB	MCP	CP	NCP	WFPS	U	> 60	M	mixed	Grain	>5120	Brown
42	SB	LCP	N/A	NBP	WFPS	U	40 - 50	M	owned	Grain	1280 - 5120	Brown
43	SB	LCP	N/A	NBP	WFPS	U	40 - 50	M	mixed	Mixed	160 -640	Black
44	SB	MCP	N/A	NCP	WFPS	SK	> 60	M	U	U	<160 acres	U
45	AB	LCP	UCP	NCP	WFPS	MB	<30	U	U	U	U	U

Appendix Table A4: Grouped Producers Identification - 3

Producer ID	Group Membership -- Method				Survey Location	Particpant Location	Age	Gender	Land Farmed	Farm Type	Farm Size (ACRES)	Soil Zone
	1: B	2: MLV	3: R	4: MLV& R								
46	CB	LCP	UCP	NBP	WFPS	U	<30	M	mixed	Grain	>5120	U
47	CB	LCP	CP	NCP	WFPS	U	<30	M	U	Grain	>5120	U
48	SB	LCP	UCP	NBP	WFPS	U	> 60	M	mixed	Mixed	1280 - 5120	Brown
49	CB	MCP	UCP	NCP	WFPS	U	> 60	M	owned	Grain	640 -1280	U
50	CB	MCP	CP	NCP	WFPS	U	30 - 40	M	mixed	Mixed	U	U
51	SB	MCP	UCP	NCP	WFPS	AB	30 - 40	M	owned	Mixed	>5120	U
52	CB	MCP	UCP	NCP	WFPS	U	40 - 50	M	owned	Mixed	640 -1280	U
53	SB	LCP	UCP	NBP	WFPS	U	40 - 50	F	owned	Livestock	1280 - 5120	U
54	CB	MCP	CP	NCP	WFPS	U	50 - 60	M	mixed	Mixed	1280 - 5120	Brown
55	SB	LCP	CP	NBP	WFPS	U	50 - 60	M	mixed	Grain	1280 - 5120	Black
56	AB	LCP	CP	NBP	WFPS	U	30 - 40	M	mixed	Grain	>5120	Dark Brown
57	CB	LCP	CP	NBP	WFPS	U	<30	M	mixed	Grain	1280 - 5120	Black
58	AB	LCP	CP	NBP	WFPS	U	<30	M	mixed	Grain	1280 - 5120	U
59	SB	LCP	CP	NCP	WFPS	U	40 - 50	M	owned	Mixed	1280 - 5120	Brown
60	AB	MCP	CP	NBP	WFPS	U	<30	M	mixed	Mixed	640 -1280	Black
61	SB	LCP	UCP	NBP	WFPS	U	> 60	M	mixed	Mixed	>5120	U
62	CB	MCP	CP	NBP	WFPS	U	40 - 50	F	mixed	Mixed	1280 - 5120	Brown
63	SB	MCP	CP	NCP	WFPS	U	<30	F	owned	Grain	160 -640	U
64	AB	LCP	CP	NBP	WFPS	SK	30 - 40	F	owned	Grain	160 -640	U
65	AB	LCP	CP	NBP	WFPS	INT	50 - 60	M	mixed	Grain	1280 - 5120	U
66	SB	LCP	CP	NBP	WFPS	U	<30	M	mixed	Mixed	1280 - 5120	U
67	SB	MCP	CP	NCP	WFPS	U	<30	M	mixed	Mixed	640 -1280	U

Appendix Table A5: Grouped Producers Identification - 4

Producer ID	Group Membership -- Method				Survey Location	Particpant Location	Age	Gender	Land Farmed	Farm Type	Farm Size (ACRES)	Soil Zone
	1: B	2: MLV	3: R	4: MLV& R								
68	AB	MCP	UCP	NBP	WFPS	U	> 60	M	owned	Grain	160 -640	U
69	CB	LCP	UCP	NBP	WFPS	U	> 60	F	owned	Grain	1280 - 5120	U
70	CB	LCP	UCP	NBP	WFPS	U	30 - 40	M	U	U	U	U
71	AB	LCP	CP	NBP	WFPS	U	<30	M	U	U	U	U
72	SB	MCP	CP	NCP	WFPS	U	<30	F	U	U	<160 acres	U
73	AB	MCP	CP	NCP	WFPS	U	40 - 50	M	owned	Grain	640 -1280	Brown
74	SB	LCP	UCP	NBP	WFPS	U	<30	F	U	U	U	U
75	SB	LCP	CP	NBP	WFPS	AB	40 - 50	M	mixed	Grain	1280 - 5120	Black
76	SB	LCP	UCP	NBP	WFPS	U	<30	M	mixed	Grain	160 -640	Brown
77	CB	MCP	UCP	NCP	WFPS	U	40 - 50	F	U	U	U	U
78	CB	LCP	UCP	NBP	WFPS	U	50 - 60	M	mixed	Grain	1280 - 5120	Brown
79	CB	LCP	UCP	NBP	WFPS	U	> 60	M	mixed	Mixed	>5120	U
80	AB	LCP	UCP	NCP	WFPS	U	<30	M	U	U	U	U
81	CB	LCP	CP	NCP	WFPS	U	<30	M	U	U	U	U
82	AB	MCP	CP	NCP	WFPS	U	40 - 50	F	mixed	Mixed	1280 - 5120	Brown
83	AB	MCP	UCP	NCP	WFPS	U	50 - 60	M	mixed	Mixed	1280 - 5120	Brown
84	CB	MCP	UCP	NCP	WFPS	U	<30	M	U	Mixed	>5120	U
85	CB	LCP	N/A	NBP	WFPS	U	<30	M	U	U	U	U
86	CB	LCP	UCP	NBP	WFPS	U	50 - 60	M	leased	Grain	160 -640	Black
87	CB	LCP	UCP	NBP	WFPS	AB	<30	M	U	U	U	U
88	SB	MCP	CP	NCP	WFPS	SK	50 - 60	M	owned	Mixed	1280 - 5120	U
89	SB	LCP	CP	NBP	WFPS	MB	30 - 40	M	owned	Grain	640 -1280	Black
90	SB	MCP	CP	NCP	WFPS	SK	50 - 60	M	owned	Mixed	1280 - 5120	Brown

Appendix Table A6: Grouped Producers Identification - 5

Producer ID	Group Membership -- Method				Survey Location	Particpant Location	Age	Gender	Land Farmed	Farm Type	Farm Size (ACRES)	Soil Zone
	1: B	2: MLV	3: R	4: MLV& R								
91	SB	LCP	N/A	NBP	WFPS	MB	30 - 40	F	owned	Grain	640 -1280	U
92	SB	LCP	CP	NBP	WFPS	U	> 60	M	owned	Grain	160 -640	U
93	SB	LCP	CP	NBP	WFPS	MB	> 60	M	mixed	Mixed	1280 - 5120	U
94	SB	MCP	CP	NCP	WFPS	U	40 - 50	M	owned	Mixed	1280 - 5120	U
95	AB	MCP	CP	NCP	WFPS	U	50 - 60	M	U	U	U	U
96	SB	MCP	UCP	NBP	WFPS	SK	50 - 60	M	owned	Grain	640 -1280	Black
97	SB	LCP	UCP	NBP	WFPS	SK	<30	M	U	U	U	U
98	SB	MCP	UCP	NCP	WFPS	U	50 - 60	M	owned	Mixed	1280 - 5120	U
99	SB	LCP	CP	NBP	WFPS	U	> 60	M	mixed	Grain	>5120	U
100	AB	LCP	UCP	NBP	WFPS	SK	> 60	M	owned	Grain	640 -1280	Brown
101	CB	MCP	N/A	NCP	WFPS	SK	50 - 60	F	owned	Grain	1280 - 5120	U
102	CB	MCP	UCP	NBP	WFPS	U	40 - 50	M	U	U	U	U
103	CB	MCP	CP	NCP	WFPS	SK	<30	M	owned	Grain	640 -1280	U
104	SB	LCP	UCP	NCP	WFPS	U	30 - 40	M	owned	Grain	160 -640	U
105	CB	LCP	UCP	NCP	WFPS	U	<30	F	owned	Livestock	1280 - 5120	U
106	SB	MCP	UCP	NCP	WFPS	SK	40 - 50	M	owned	Mixed	160 -640	U
107	SB	MCP	CP	NCP	WFPS	SK	> 60	F	owned	Mixed	160 -640	U
108	SB	MCP	CP	NCP	WFPS	SK	50 - 60	M	leased	Mixed	640 -1280	U
109	AB	LCP	UCP	NBP	FFP	SK	<30	M	mixed	Grain	1280 - 5120	Black
110	CB	LCP	UCP	NBP	FFP	U	50 - 60	M	mixed	Grain	1280 - 5120	Dark Brown
111	CB	LCP	N/A	NBP	FFP	U	50 - 60	M	leased	Grain	640 -1280	U
112	CB	MCP	CP	NCP	FFP	U	50 - 60	M	owned	Grain	160 -640	U

Appendix Table A7: Grouped Producers Identification - 6

Producer ID	Group Membership -- Method				Survey Location	Participant Location	Age	Gender	Land Farmed	Farm Type	Farm Size (ACRES)	Soil Zone
	1: B	2: MLV	3: R	4: MLV&R								
113	AB	LCP	CP	NCP	FFP	U	> 60	F	Owned	Grain	640 -1280	U
114	SB	MCP	UCP	NBP	FFP	U	50 - 60	M	Mixed	Grain	1280 - 5120	U
115	CB	LCP	CP	NBP	FFP	U	> 60	F	Owned	Mixed	640 -1280	U
131	SB	MCP	CP	NCP	ABC	INT	50 - 60	M	Mixed	Mixed	640 -1280	Black
140	SB	MCP	CP	NCP	APAS	SK	<30	F	U	U	U	U
141	AB	LCP	CP	NBP	APAS	SK	50 - 60	M	Mixed	Mixed	640 -1280	Black
142	SB	LCP	N/A	NBP	APAS	SK	> 60	M	Owned	Mixed	1280 - 5120	Dark Brown
143	AB	MCP	CP	NCP	APAS	SK	> 60	M	Mixed	Mixed	1280 - 5120	Black
144	SB	MCP	CP	NCP	APAS	SK	<30	M	Leased	Grain	<160 acres	Dark Brown
145	SB	LCP	CP	NBP	APAS	SK	30 - 40	F	Owned	Grain	160 -640	Dark Brown
146	SB	LCP	CP	NCP	APAS	SK	> 60	F	Owned	Grain	640 -1280	Dark Brown
147	SB	LCP	CP	NBP	APAS	SK	50 - 60	M	Owned	Mixed	640 -1280	Dark Brown
148	SB	LCP	N/A	NBP	APAS	SK	40 - 50	M	Leased	Grain	160 -640	Black
149	SB	MCP	CP	NCP	APAS	SK	30 - 40	M	Leased	Grain	160 -640	Dark Brown
150	SB	LCP	CP	NBP	APAS	SK	50 - 60	M	Owned	Grain	160 -640	Black
151	SB	LCP	CP	NBP	APAS	SK	<30	F	U	U	U	U
152	SB	MCP	N/A	NBP	APAS	SK	30 - 40	F	Mixed	Grain	1280 - 5120	U
153	AB	N/A	N/A	N/A	APAS	SK	50 - 60	M	Mixed	Mixed	1280 - 5120	U
154	AB	N/A	CP	N/A	APAS	SK	40 - 50	M	owned	Mixed	1280 - 5120	U
155	SB	MCP	CP	NCP	APAS	SK	<30	F	U	Mixed	640 -1280	U
156	SB	LCP	CP	NBP	APAS	SK	40 - 50	M	mixed	Mixed	>5120	Black
157	SB	LCP	CP	NCP	APAS	SK	30 - 40	M	owned	Grain	640 -1280	U
158	SB	LCP	UCP	NBP	APAS	SK	50 - 60	M	mixed	Mixed	640 -1280	Brown

Appendix Table A8: Relationship between Respondent Age, Gender, and Farm Type

Gender	Age	Farm Type				
		Grain	Livestock	Mix	NS	% of Total Respondents
Male		% of in Farm Type				
	<30	33.3%	7.4%	33.3%	25.9%	20.0%
	30 - 40	50.0%	0.0%	40.0%	10.0%	7.4%
	40 - 50	38.1%	14.3%	42.9%	4.8%	15.6%
	50 - 60	42.9%	0.0%	53.6%	3.6%	20.7%
	> 60	42.1%	5.3%	47.4%	5.3%	14.1%
	% of All Males	**31.9%**	**4.4%**	**34.1%**	**8.1%**	**77.8%**
Female		% of in Farm Type				
	<30	10.0%	10.0%	30.0%	50.0%	7.4%
	30 - 40	83.3%	0.0%	0.0%	16.7%	4.4%
	40 - 50	0.0%	40.0%	40.0%	20.0%	3.7%
	50 - 60	100.0%	0.0%	0.0%	0.0%	1.5%
	> 60	60.0%	0.0%	40.0%	0.0%	3.7%
	% of All Females	**8.1%**	**2.2%**	**5.2%**	**1.5%**	**20.7%**
NS						**1.5%**
% of Total Respondents		**40.0%**	**6.7%**	**40.0%**	**13.3%**	**100.0%**
Note: NS=Unspecified						

Appendix Table A9: Relationship between Respondent Age, Gender, and Farm Ownership

Gender	Age	Farm Ownership				
		Owned	Leased	Mix	NS	% of Total Respondents
Male		% of in Farm Ownership				
	<30	22.2%	3.7%	33.3%	40.7%	20.0%
	30 - 40	40.0%	10.0%	30.0%	20.0%	7.4%
	40 - 50	47.6%	4.8%	42.9%	4.8%	15.6%
	50 - 60	28.6%	10.7%	57.1%	3.6%	20.7%
	> 60	57.9%	0.0%	36.8%	5.3%	14.1%
	% of All Males	**28.9%**	**4.4%**	**33.3%**	**10.4%**	**77.8%**
Female		% of in Farm Ownership				
	<30	20.0%	0.0%	20.0%	60.0%	7.4%
	30 - 40	83.3%	0.0%	16.7%	0.0%	4.4%
	40 - 50	40.0%	0.0%	40.0%	20.0%	3.7%
	50 - 60	100.0%	0.0%	0.0%	0.0%	1.5%
	> 60	100.0%	0.0%	0.0%	0.0%	3.7%
	% of All Females	**11.9%**	**0.0%**	**3.7%**	**4.4%**	**20.7%**
NS						**1.5%**
% of Total Respondents		**40.7%**	**4.4%**	**37.8%**	**17.0%**	**100.0%**
Note: NS=Unspecified						

Appendix 2.3 Summary Statistics of Producer Survey Response

Appendix Table A10: Statistics Table for Q1-6

Statistic	Question No.				
	1	2	4	5	6
	Climate is Changing	Impact of Past Extreme Event	Climate Change Impact	Years before Climate Change Affect	Human Activities Causation
Most Likely Value					
Mean	5.62	5.20	4.51	3.13	5.00
Median	5.99	5.31	4.72	2.38	4.95
Mode	6.23	7.08	5.28	1.31	7.83
Standard Deviation	2.14	2.37	1.72	2.47	2.33
Minimum	0.33	0.19	0.38	0.19	0.14
Maximum	9.91	10.00	8.63	9.77	9.81
Range					
Mean	2.16	2.05	2.11	1.51	2.02
Median	2.64	2.26	2.36	1.62	2.31
Mode	0.10	0.10	0.10	0.10	0.10
Standard Deviation	1.41	1.40	1.59	1.19	1.42
Minimum	0.10	0.10	0.10	0.10	0.10
Maximum	5.09	5.94	6.70	4.08	5.09

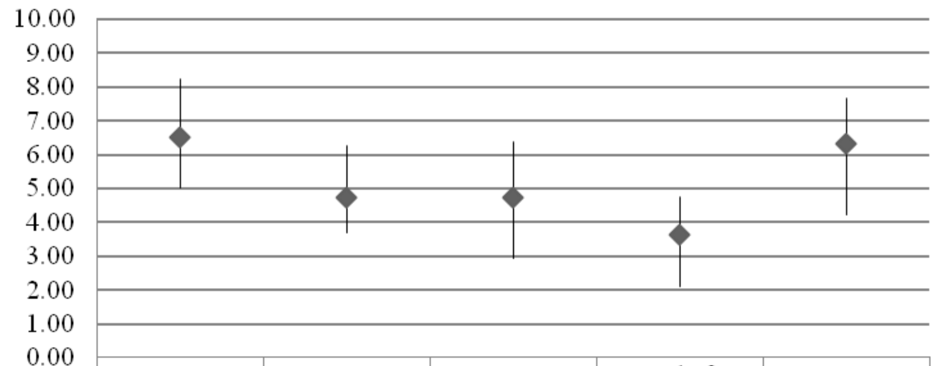
Appendix Table A11: Summary Statistics of Producer Survey Response to Q7-Q14

Statistic	Question No.							
	7	8	9	10	11	12	13	14
	Climatologists /Scientists	"Environmental Group"	Newspaper and Magazines	Radio and TV	Web	Friend	"Family Members"	"Other" Influence
Most Likely Value								
Mean	4.87	3.44	3.89	4.05	3.84	3.40	3.71	5.03
Median	5.05	2.92	4.22	4.36	3.82	3.18	3.75	5.24
Mode	6.32	1.23	3.87	5.47	0.47	2.92	5.38	3.68
Standard Deviation	2.09	2.45	2.00	2.32	2.61	2.07	2.08	2.62
Minimum	0.33	0.14	0.28	0.28	-0.05	0.05	0.07	0.09
Maximum	8.77	9.62	8.44	9.72	9.62	10.09	9.25	9.55
Range								
Mean	1.93	1.84	1.73	1.74	1.58	1.67	1.69	1.88
Median	2.26	1.98	2.12	1.98	1.79	1.93	2.03	2.22
Mode	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Standard Deviation	1.45	1.40	1.36	1.37	1.33	1.36	1.37	1.56
Minimum	0.10	0.10	0.10	0.10	-0.57	-0.09	0.09	0.10
Maximum	5.19	6.98	4.48	4.43	4.34	5.00	5.00	4.72

Appendix Table A12: Summary Statistics of Producer Survey Response to Q15-Q17

Statistic	Question No.		
	15	16	17
	Experts on Climate Change	Experts on Climate Change Impact	Experts on how long
Most Likely Value			
Mean	6.65	4.01	2.65
Median	7.03	4.10	2.17
Mode	7.83	2.92	3.69
Standard Deviation	1.82	1.60	2.02
Minimum	1.37	0.28	-0.75
Maximum	10.17	7.31	10.85
Range			
Mean	2.10	2.25	1.57
Median	2.45	2.41	1.69
Mode	0.10	0.10	0.10
Standard Deviation	1.87	1.97	1.29
Minimum	0.09	0.10	0.10
Maximum	11.70	10.94	10.00

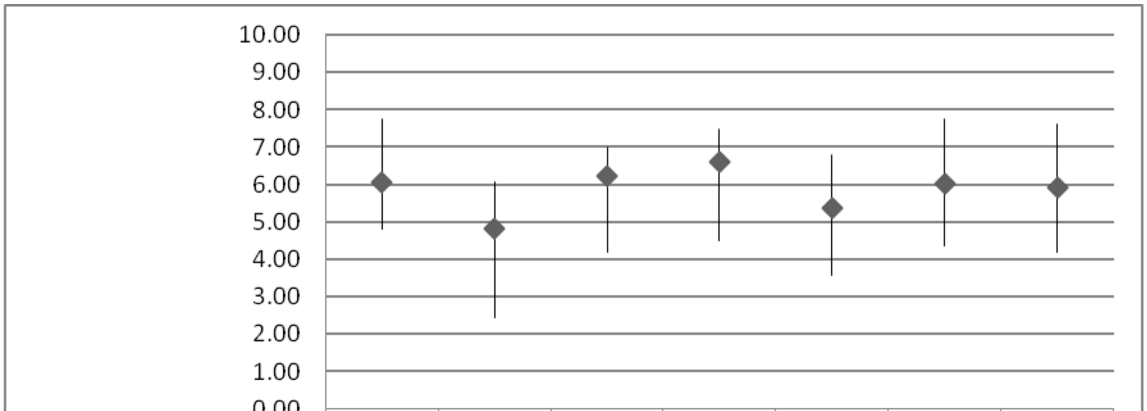
Appendix 2.4: Frequency of Experts' Responses



	Climate is Changing	Impact of Past	Impact in Prairie	Years before Climate Change Affect	Man-kind Causation
Mean of Lowerlimite	5.01	3.69	2.92	2.09	4.20
Mean of Upper Limite	8.22	6.25	6.38	4.75	7.67
◆ Mean of MLV	6.52	4.73	4.75	3.65	6.34

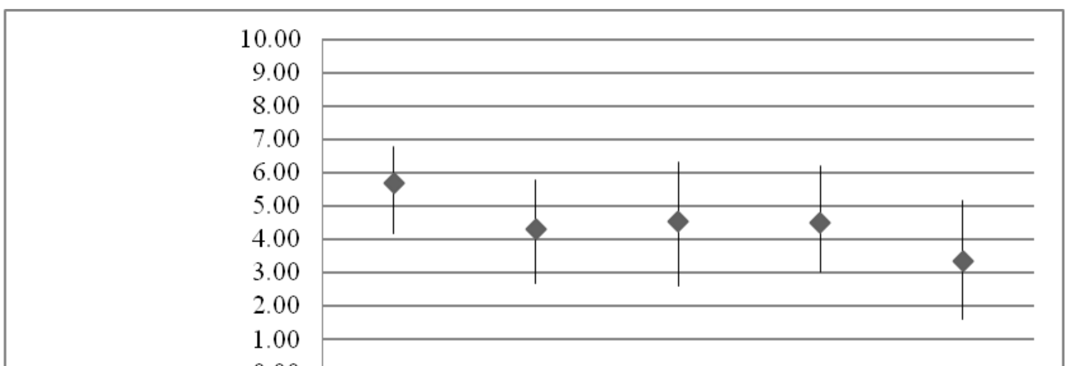
Appendix Figure A1: Mean Value of Experts' *MLV* and *R* (Q1-6)[30]

[30] Similar to the producer survey, the vertical line indicates expert uncertainty range and the triangle indicates their *MLV*.



	"Climatologists/Scientists"	"Environmental Group"	"Newspaper and Magazines"	"Radio and TV"	"Web"	"Friend"	"Family Members"
Mean of Lowerlimite	4.79	2.43	4.21	4.51	3.57	4.35	4.20
Mean of Upper Limite	7.76	6.06	7.00	7.48	6.80	7.74	7.64
◆ Mean of MLV	6.05	4.82	6.23	6.60	5.37	6.02	5.93

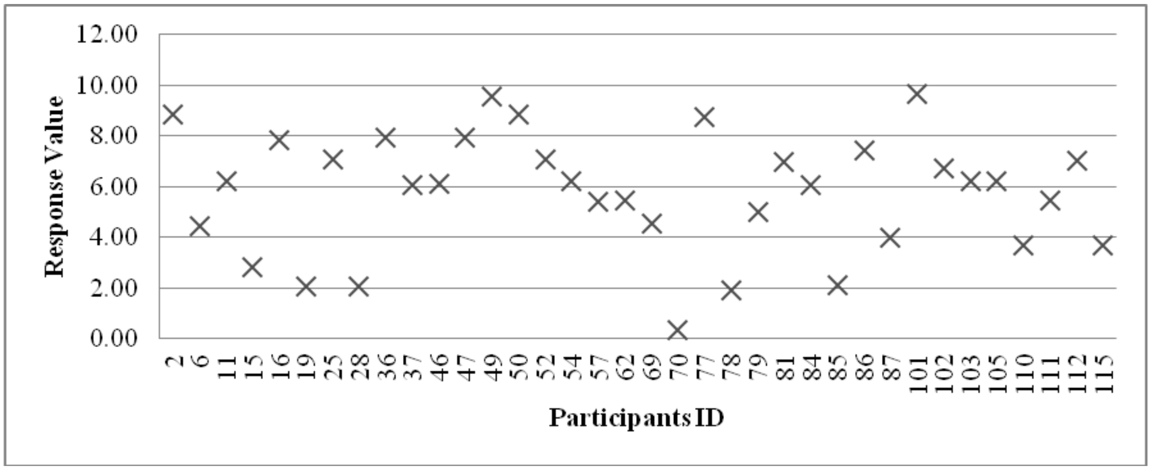
Appendix Figure A2: Mean Value of Experts' *MLV* and *R* (Q7-13)



	Public Concern	Canadian Media Portraying	Farmer Concern	Farmers' View on Benefit /Cost	Farmers' View on How Long
Mean of Lowerlimite	4.16	2.66	2.59	3.03	1.62
Mean of Upper Limite	6.80	5.79	6.33	6.23	5.18
◆ Mean of MLV	5.68	4.31	4.55	4.51	3.34

Appendix Figure A3: Mean Value of Experts' *MLV* and *R* (Q18-22)

Appendix 2.5 Producer Groups Based on Bound Symmetry



Appendix Figure A4: Response Value of *Certain Producers*

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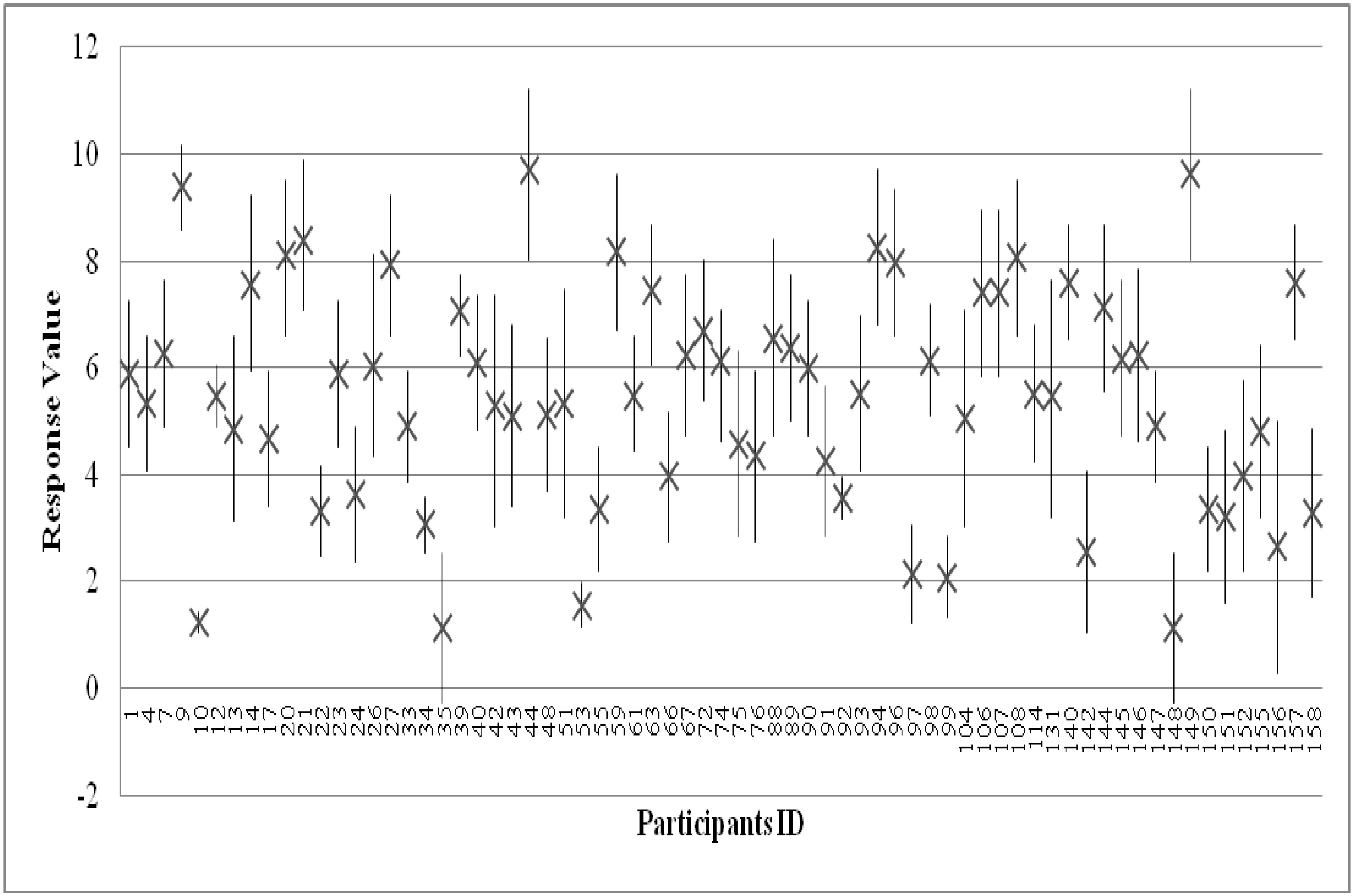
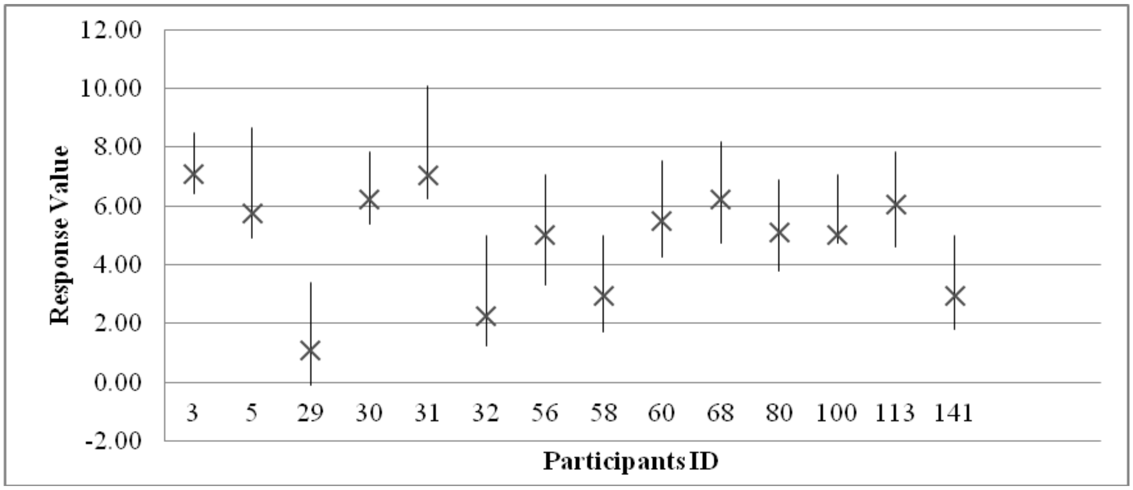
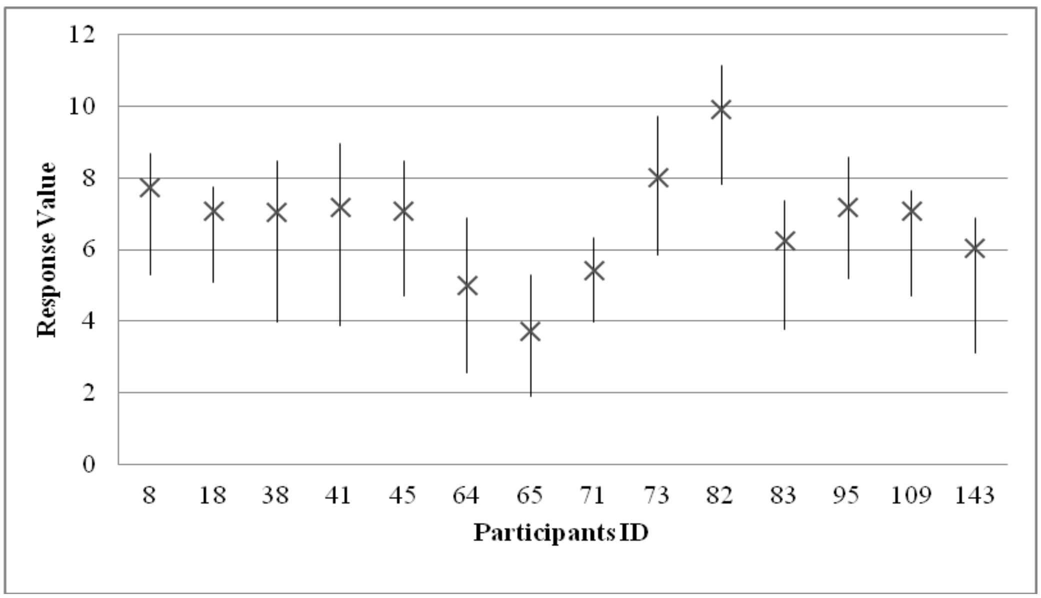


Appendix Figure A5: Response Value of Symmetric Uncertainty Producers



Appendix Figure A6: Response Value of *Upside Risk Producers*



Appendix Figure A7: Response Value of *Downside Risk Producers*

Appendix 2.6: Demographics and Asymmetric Response

Appendix Table A13: Estimated Multinomial Logit Model

Parameter Estimates							
Typology*		B	Std. Error	Wald	df	Sig.	Exp(B)
1**	Intercept	0.54	1.24	0.19	1	0.67	
	Type	-0.24	0.32	0.56	1	0.46	0.79
	Tenure	-0.49	0.32	2.33	1	0.13	0.61
	Size	0.23	0.33	0.49	1	0.48	1.26
2**	Intercept	1.71	1.02	2.79	1	0.10	
	Type	0.40	0.26	2.33	1	0.13	1.49
	Tenure	-0.38	0.27	1.97	1	0.16	0.68
	Size	-0.24	0.27	0.77	1	0.38	0.79

* The reference category is 3**
** 1 indicates *certain producer*, 2 indicates *symmetric producer*, and 3 indicates *asymmetric producer*.

Appendix Table A14: Prediction Rates

Classification				
Observed	Predicted			
	1*	2*	3*	Percent Correct
1*	0	23	1	0%
2*	0	59	2	97%
3*	0	23	2	8%
Overall Percentage	0%	95%	5%	55%

Appendix 2.7: Tables from Cluster Analysis Based on R

Appendix Table A15: BIC for 1-15 Auto-Clusters Groupings

Auto-Clustering				
Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change[a]	Ratio of BIC Changes[b]	Ratio of Distance Measures[c]
1	1281.6			
2	855.2	-426.4	1.0	4.0
3	850.1	-5.2	0.0	1.9
4	911.8	61.7	-0.1	1.6
5	999.6	87.8	-0.2	2.0
6	1110.4	110.8	-0.3	1.1
7	1222.9	112.5	-0.3	1.1
8	1337.0	114.2	-0.3	1.2
9	1454.6	117.6	-0.3	1.1
10	1573.6	119.0	-0.3	1.0
11	1692.8	119.2	-0.3	1.1
12	1813.8	120.9	-0.3	1.2
13	1936.5	122.7	-0.3	1.1
14	2059.8	123.3	-0.3	1.1
15	2184.2	124.4	-0.3	1.0

a. The changes are from the previous number of clusters in the table.

b. The ratios of changes are relative to the change for the two cluster solution.

c. The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

Appendix Table A16: ANOVA Table for R Cluster

ANOVA						
R *	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Q1	135.8	1	0.8	117	160.8	0.0
Q2	132.1	1	0.9	117	153.2	0.0
Q4	167.4	1	1.1	117	156.1	0.0
Q5	40.7	1	1.1	117	35.7	0.0
Q6	146.6	1	0.7	117	201.8	0.0
Q7	186.4	1	0.5	117	352.6	0.0
Q8	152.4	1	0.9	117	177.3	0.0
Q9	167.2	1	0.4	117	375.9	0.0
Q10	164.0	1	0.4	117	407.7	0.0
Q11	138.5	1	0.6	117	234.6	0.0
Q12	144.3	1	0.6	117	228.3	0.0
Q13	166.5	1	0.5	117	337.0	0.0
Q15	183.2	1	1.6	117	114.4	0.0
Q16	156.4	1	2.3	117	66.6	0.0

* R is range in uncertainty

Appendix 2.8: Tables from Cluster Analysis Based on MLV and R

Appendix Table A17: KMO Measure of MLV, Rand B and Question Combinations

Different Combination of Questions	MLV,R,B of Q1-Q6	MLV,B of Q1-Q6	MLV,R of Q1-Q6	MLV,R,B of Q1,Q4,Q6
KMO Measure	0.695	0.523	0.640	0.748

Appendix Table A18: Factors Extracted from Producer Response

Total Variance Explained						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factors	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.6	43.0	43.0	2.6	43.0	43.0
2	1.7	29.1	73.0	1.7	29.1	72.1
3	0.8	13.0	85.1			
4	0.5	8.2	93.2			
5	0.2	4.1	97.3			
6	0.2	2.7	100.0			
Extraction Method: Principal Component Analysis.						

Appendix Table A19: Rotated Factor Matrix

Component Matrix		
	Factor	
	1	2
Q1-MLV	0.0	0.8
Q4-MLV	0.1	-0.6
Q6-MLV	0.0	0.8
Q1-R	0.9	0.1
Q4-R	0.9	-0.1
Q6-R	0.9	0.1

Appendix Table A20 : Factor Centroid Values

Final Cluster Centroids by Factors		
Factor score	Cluster	
	1(69)*	2(63)*
R factor	0.0	0.0
MLV factor	-0.8	0.9

Appendix 2.9: Crosstab Comparison of Method 1 and Method 3

Appendix Table A21: Group Members Comparison for Method 1 and Method 3

Comparison of Common Members										
Cluster Type		Method 3						Grand Total	
		NCP**		NBP**		N/A			
Method 1	MCP*	62	46%	14	10%	1	1%	77	57%
	LCP*	7	5%	48	36%	0	0%	55	41%
	N/A	0	0%	1	1%	2	1%	3	2%
Grand Total		69	51%	63	47%	3	2%	135	100%

*MCP indicates *more concerned producer*, and LCP indicates *less concerned producer*

** NBP indicates *net benefit producer*, and UP indicates *net cost producer*

Appendix 2.10 Crosstab Comparison of Method 2 and Method 3

Appendix Table A22: Group Members Comparison for Method 2 and Method 3

Comparison of Common Members									
Cluster Type		Method 3						Grand Total	
		NBP**		NCP**		N/A			
Method 2	CP*	27	20%	19	14%	0	0%	46	34%
	UCP*	32	24%	39	29%	2	1%	73	54%
	N/A	10	7%	5	4%	1	1%	16	12%
Grand Total		69	51%	63	47%	3	2%	135	100%

* CP indicates *confident producer*, and UCP indicates *unconfident producer*

** NBP indicates *net benefit producer*, and UCP indicates *net cost producer*

Appendix 2.11 Group Membership from Method 1 and by Demographic Characteristic

Appendix Table A23: Cross Tabulation of *LCP*/*MCP* (Method 1) Groupings and Demographic Characteristics

Producer Demographic Characteristic		LCP* Count	LCP* % of LCP	LCP* % of Total	MCP* Count	MCP* % of MCP	MCP* % of Total	N/A Count	N/A % of N/A	N/A % of Total
Gender	Male	62	81%	46%	40	73%	30%	2	67%	1%
	Female	13	17%	10%	15	27%	11%	1	33%	1%
	N/A	2	3%	1%	0	0%	0%	0	0%	0%
	Subtotal	77	100%	57%	55	100%	41%	3	100%	2%
Age	<30	22	29%	16%	13	24%	10%	0	0%	0%
	30-40	9	12%	7%	7	13%	5%	0	0%	0%
	40-50	14	18%	10%	12	22%	9%	1	33%	1%
	50-60	14	18%	10%	15	27%	11%	1	33%	1%
	>60	17	22%	13%	8	15%	6%	1	33%	1%
	N/A	1	1%	1%	0	0%	0%	0	0%	0%
	Subtotal	77	100%	57%	55	100%	41%	3	100%	2%
Tenure	Owned	28	36%	21%	24	44%	18%	1	33%	1%
	Leased	3	4%	2%	3	5%	2%	0	0%	0%
	Mixed	31	40%	23%	18	33%	13%	2	67%	1%
	N/A	15	19%	11%	10	18%	7%	0	0%	0%
	Subtotal	77	100%	57%	55	100%	41%	3	100%	2%
Type	Grain	36	47%	27%	18	33%	13%	0	0%	0%
	Livestock	5	6%	4%	4	7%	3%	0	0%	0%
	Mixed	23	30%	17%	26	47%	19%	3	100%	2%
	N/A	13	17%	10%	6	11%	4%	0	0%	0%
	Subtotal	77	100%	57%	54	98%	40%	3	100%	2%
Size	<160	0	0%	0%	5	9%	4%	0	0%	0%
	160-640	10	13%	7%	6	11%	4%	0	0%	0%
	640-1280	16	21%	12%	15	27%	11%	1	33%	1%
	1280-5120	26	34%	19%	21	38%	16%	2	67%	1%
	>5120	12	16%	9%	3	5%	2%	0	0%	0%
	N/A	13	17%	10%	5	9%	4%	0	0%	0%
	Subtotal	77	100%	57%	55	100%	41%	3	100%	2%

*MCP indicates *more concerned producer*, and LCP indicates *less concerned producer*

Appendix 2.12 Group Membership from Method 2 and by Demographic Characteristic

Appendix Table A24: Cross Tabulation of *UCP*/*CP* (Method 2) Groupings and Demographic Characteristic

Producer Demographic Characteristic		Producer Groups								
		UCP*			CP*			N/A		
		Count	% of LCP	% of Total	Count	% of MCP	% of Total	Count	% of N/A	% of Total
Gender	Male	38	83%	28%	56	77%	41%	10	63%	7%
	Female	8	17%	6%	16	22%	12%	5	31%	4%
	N/A		0%	0%	1	1%	1%	1	6%	1%
	Subtotal	46	100%	34%	73	100%	54%	16	100%	12%
Age	<30	14	30%	10%	20	27%	15%	2	13%	1%
	30-40	5	11%	4%	8	11%	6%	3	19%	2%
	40-50	8	17%	6%	15	21%	11%	4	25%	3%
	50-60	9	20%	7%	18	25%	13%	3	19%	2%
	>60	10	22%	7%	11	15%	8%	3	19%	2%
	N/A		0%	0%	1	1%	1%	1	6%	1%
	Subtotal	46	100%	34%	73	100%	54%	16	100%	12%
Tenure	Owned	20	43%	15%	28	38%	21%	5	31%	4%
	Leased	4	9%	3%	4	5%	3%	2	13%	1%
	Mixed	12	26%	9%	28	38%	21%	6	38%	4%
	N/A	10	22%	7%	13	18%	10%	3	19%	2%
	Subtotal	46	100%	34%	73	100%	54%	16	100%	12%
Type	Grain	18	39%	13%	33	45%	24%	6	38%	4%
	Livestock	7	15%	5%	6	8%	4%	1	6%	1%
	Mixed	18	39%	13%	29	40%	21%	8	50%	6%
	N/A	3	7%	2%	5	7%	4%	1	6%	1%
	Subtotal	46	100%	34%	73	100%	54%	16	100%	12%
Size	<160	1	2%	1%	3	4%	2%	1	6%	1%
	160-640	5	11%	4%	8	11%	6%	3	19%	2%
	640-1280	11	24%	8%	19	26%	14%	2	13%	1%
	1280-5120	17	37%	13%	26	36%	19%	7	44%	5%
	>5120	5	11%	4%	9	12%	7%	1	6%	1%
	N/A	7	15%	5%	8	11%	6%	2	13%	1%
	Subtotal	46	100%	34%	73	100%	54%	16	100%	12%

* CP indicates confident producer, and UCP indicates unconfident producer

APPENDIX 3: SPSS SYNTAX

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GET
 FILE='E:\2010\relationship between groups and demographic.sav'.
SAVE OUTFILE='E:\2010\farmer attitude data.sav'
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 /CRITERIA MINEIGEN(1) ITERATE(25)
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 /METHOD=CORRELATION.
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 /ROTATION NOROTATE
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 /METHOD=CORRELATION.
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 /MISSING LISTWISE
 /ANALYSIS FAC1_1 FAC2_1 FAC3_1
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 /CRITERIA MINEIGEN(1) ITERATE(25)
 /EXTRACTION PC
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 /CRITERIA MINEIGEN(1) ITERATE(25)
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 /PRINT INITIAL ANOVA.
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 /MISSING ANALYSIS
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GET
 FILE='E:\2010\relationship between groups and demographic.sav'.
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 /MISSING=PAIRWISE.
TWOSTEP CLUSTER
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@1_MLV13
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 /NUMCLUSTERS AUTO 15 BIC
 /HANDLENOISE 0
 /MEMALLOCATE 64
 /CRITERIA INITHRESHOLD(0) MXBRANCH(8) MXLEVEL(3)
 /PLOT BARFREQ PIEFREQ VARCHART COMPARE BYCLUSTER
 /PRINT IC COUNT SUMMARY
 /SAVE VARIABLE=TSC_1842.
GET
```

```
 FILE='E:\2010\farmer attitude data.sav'.
QUICK CLUSTER @1_MLV1 @1_MLV2 @1_MLV6 @1_MLV9 @1_MLV12 @1_MLV13
 /MISSING=LISTWISE
 /CRITERIA=CLUSTER(2) MXITER(10) CONVERGE(0)
 /METHOD=KMEANS(NOUPDATE)
 /SAVE CLUSTER DISTANCE
 /PRINT INITIAL ANOVA CLUSTER DISTAN.
GET
 FILE='E:\2010\farmer attitude data.sav'.
QUICK CLUSTER @1_MLV1 @1_MLV2 @1_MLV6 @1_MLV9 @1_MLV12 @1_MLV13
 /MISSING=LISTWISE
 /CRITERIA=CLUSTER(3) MXITER(10) CONVERGE(0)
 /METHOD=KMEANS(NOUPDATE)
 /SAVE CLUSTER DISTANCE
 /PRINT INITIAL ANOVA CLUSTER DISTAN.
GET
 FILE='E:\2010\farmer attitude data.sav'.
QUICK CLUSTER @1_R1 @1_R2 @1_R4 @1_R5 @1_R6 @1_R7 @1_R8 @1_R9 @1_R10
@1_R11 @1_R12 @1_R13 @1_R15 @1_R16
 /MISSING=LISTWISE
 /CRITERIA=CLUSTER(3) MXITER(10) CONVERGE(0)
 /METHOD=KMEANS(NOUPDATE)
 /SAVE CLUSTER DISTANCE
 /PRINT INITIAL ANOVA CLUSTER DISTAN.
GET
 FILE='E:\2010\farmer attitude data.sav'.
QUICK CLUSTER @1_R1 @1_R2 @1_R4 @1_R5 @1_R6 @1_R7 @1_R8 @1_R9 @1_R10
@1_R11 @1_R12 @1_R13 @1_R15 @1_R16
 /MISSING=LISTWISE
 /CRITERIA=CLUSTER(2) MXITER(10) CONVERGE(0)
 /METHOD=KMEANS(NOUPDATE)
 /SAVE CLUSTER DISTANCE
 /PRINT INITIAL ANOVA CLUSTER DISTAN.

GET DATA
 /TYPE=ODBC
 /CONNECT='DSN=Excel Files;DBQ=F:\2010\thesis writing\data\producer membership and
demographic.xlsx;DriverId=1046;FIL=excel 12.0;MaxBufferSize=2048;PageTimeout=5;'
 /SQL='SELECT `Participant ID` AS Participant_ID, `Survey Type` AS Survey_Type, `Survey
Location` AS Survey_Location, `Participant Type` AS Participant_Type, ParticpantLocation, age,
gender, `land farmed` AS land_farmed, `farm type` AS farm_type, '+
'`farm size` AS farm_size, `Typology (B)` AS Typology_B, `method 1(MLV)` AS method_1MLV,
`method 2( R )` AS method_2_R_, `method 3(MLV+R)` AS method_3MLVR FROM `Sheet2$`'
 /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
```

```
DATASET NAME DataSet1 WINDOW=FRONT.
NOMREG Typology_B (BASE=LAST ORDER=ASCENDING) BY age WITH gender land_farmed farm_type farm_size
 /CRITERIA CIN(95) DELTA(0) MXITER(100) MXSTEP(5) CHKSEP(20) LCONVERGE(0) PCONVERGE(0.000001) SINGULAR(0.00000001)
 /MODEL=| FORWARD=farm_size land_farmed age gender farm_type
 /STEPWISE=PIN(.05) POUT(0.1) MINEFFECT(0) RULE(SINGLE) ENTRYMETHOD(LR) REMOVALMETHOD(LR)
 /INTERCEPT=INCLUDE
 /PRINT=CLASSTABLE PARAMETER SUMMARY LRT CPS STEP MFI
 /SAVE ESTPROB PREDCAT PCPROB ACPROB.
NOMREG Typology_B (BASE=LAST ORDER=ASCENDING) WITH gender land_farmed farm_type farm_size age
 /CRITERIA CIN(95) DELTA(0) MXITER(100) MXSTEP(5) CHKSEP(20) LCONVERGE(0) PCONVERGE(0.000001) SINGULAR(0.00000001)
 /MODEL=farm_type land_farmed farm_size
 /STEPWISE=PIN(.05) POUT(0.1) MINEFFECT(0) RULE(SINGLE) ENTRYMETHOD(LR) REMOVALMETHOD(LR)
 /INTERCEPT=INCLUDE
 /PRINT=CLASSTABLE PARAMETER SUMMARY LRT CPS STEP MFI
 /SAVE ESTPROB PREDCAT PCPROB ACPROB.
SAVE OUTFILE='F:\2010\thesis writing\data\classification and demographic.sav'
 /COMPRESSED.
LOGISTIC REGRESSION VARIABLES method_2_R_
 /METHOD=FSTEP(LR) age gender land_farmed farm_type farm_size
 /METHOD=ENTER farm_type farm_size gender land_farmed
 /SAVE=PRED COOK SRESID
 /CLASSPLOT
 /PRINT=GOODFIT
 /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
LOGISTIC REGRESSION VARIABLES method_1MLV
 /METHOD=FSTEP(LR) age gender land_farmed farm_type farm_size
 /METHOD=ENTER farm_type farm_size gender land_farmed
 /SAVE=PRED COOK SRESID
 /CLASSPLOT
 /PRINT=GOODFIT
 /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

APPENDIX 4: CLUSTERING ANALYSIS BASED ON *MLV*, *R* AND *B* RESPONSES

In the previous two sections, cluster analysis based on *MLV* or *R* responses was presented. In this section, the cluster analysis is based on the *MLV*, *R* and *B* responses. With an increased number of responses, the total variance of responses will increase. Therefore, only responses to the climate change questions (Q1 to Q6, excluding Q3) are selected for this clustering analysis.[31] To further facilitate clustering analysis, factor analysis is performed to reduce the number of variables. According to Berkhin (2005), latent factors that drive responses to various questions are first extracted, and cluster analysis is performed over the extracted factors to minimize within-group variance relative to across-group variances.

A total of six factors are extracted from the combination of *MLV* and *R* for Q1, Q4, and Q6 (same as the number of variables). According to the factor matrix table, factor 1 is labeled as *R factor* and factor 2 is labeled as *MLV factor* since factor 1 is highly correlated to *R* value and factor 2 is highly correlated to *MLV* value (Table A17, Appendix 2.8). They are used in the subsequent cluster analysis.

Appendix 4.1: MLV and R Cluster Analysis Based on a Two-Cluster Grouping

From the above analysis, two factors are selected: the *MLV* and *R* factors are used to identify the two clusters. This results in 69 producers in Group 1 and 63 producers in Group 2 (Table A18, Appendix 2.8). Accordingly, the *MLV* is able to discriminate between the two groups as indicated by differing *MLV* centroids. The *R* criterion does not discriminate well as indicated by nearly

[31] Since Question 3 has a different question format, it is excluded from clustering analysis.

identical centroids within a question and hence, does not play an important role in the clustering process. In other words, the two clustering groups are mainly based on the differences of *MLV*.

Omitting producer *R* responses, Group 1 displays less concern as to climate change with a *MLV* of 4.3 for question one. Group 1 producers also do not believe global climate change is mainly caused by human activity, and think the effect of climate change might bring net benefit to Canadian prairie farm production. Hence, Group 1 is labelled as *net benefit producers (NBP).*

In contrast, Producers in Group 2 are more concerned with climate change. They believe that human activity is somewhat responsible for global climate change (a value of 6.8), and they think that climate change will have a negative impact on Canadian prairie farm production. Hence, Cluster 2 producer is labeled as *net cost producers (NCP).*

It is safe to assume that those producers, who believe there are net benefits of climate change (*NBP*), would be happy with the change. Conversely, those who believe climate change adversely affects the prairies economy (*NCP)*, would be more concern about climate change as a serious issue.

Appendix Table A25: Mean Cluster Responses for Q1, Q4, Q6

Mean Cluster Responses, Two Cluster Groupings, MLV* and R**				
Survey Questions	Two Clusters			
	NBP		NCP	
	MLV*	R**	MLV*	R**
Q1. Do you think that global climate is changing?	4.3	2.0	7.1	2.3
Q4. What do you think the effect of climate change is on Canadian prairie farm production?	5.3	2.2	3.6	2.1
Q6. Do you believe that global climate change is mostly caused by human activities?	3.4	2.0	6.8	2.0

* MLV is most likely value, ** R is range in uncertainty

*** NBP indicates *net benefit producer* and NCP indicates *net cost producer*

Appendix 4.2: An ANOVA of the Two Group Responses

Again, ANOVA (Table A30) is used to test how well the two factors discriminate between clusters. The *MLV* factor is highly significant (*p*=0.000) as indicated by its F value. However, the *R* factor generates a larger MSE (mean square error) with a corresponding much lower F value and probability (*p*=0.925), indicating that it is very unhelpful in forming and differentiating between clusters. This observation is also supported by Appendix Table A20 (Appendix 2.8). In Appendix Table A20, the final cluster centroid *R* factors are 0.0 for both Cluster 1 and Cluster 2. However, the absolute value of the *MLV* factor cluster centers are nearly opposite at -0.8 and 0.9. This indicates that the *MLV* variable is the more important index for this clustering analysis.

Appendix Table A26: ANOVA Table for *MLV* and *R* Cluster

ANOVA						
Factor *	Cluster		Error			
	Mean Square	df	Mean Square	df	F	Sig.
R	0.009	1	1.008	130	0.009	0.925
MLV	87.809	1	0.332	130	264.295	0.000

* Factors are extracted from MLV and R of Q1, Q4, Q6.

Because the *R* response variable does not play a significant role but *MLV* responses do in forming a group in Method 3, it is similar to Method 1.